THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 29. Thursday, January 10, 1924. No. 386.

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

Contents.

	PAGE
Mould Gases	25
Correspondence	26
Catalogues Received	26
Supplementary List of Calendars, etc., Received	26
Foundry Queries	26
Tellurium in Steel	26
Iron and Steel Trades between Great Britain and Sweden	27
Book Reviews	27
The Iron and Steel Industry of South Africa	28
Relative Values of Feeders or Denseners in Grey Iron and Malleable Iron	29
Book Review	33
A Discussion on Cupola Practice	34
Improvements in Foundry Practice	37
Institute of British Foundrymen	38
Trade Talk	40
Japan Steel Works	41
The German Pig-Iron Union	42
Metals in 1923	43
Contracts Open	44
Company News	44
Personal	44
Iron and Steel Markets	46

Forthcoming Events.

JANUARY 11.

Institute of British Foundrymen (Sheffield Branch):—Ordinary meeting at Sheffield. "The Influence of Casting Temperature on Aluminium Alloys," Paper by F. H. Hurren.

JANUARY 12.

Institute of British Foundrymen (West Riding of Yorkshire Branch):—Ordinary meeting at Halifax. "The Founding of Phosphor Bronzes," Paper by F. W. Rowe.

Institute of British Foundrymen (Lancashire Branch):—Ordinary meeting at Manchester. "The Practical Value of Modern Non-Ferrous Alloys," Paper by S. F. Barclay, D.Sc.

Institute of British Foundrymen (Scottish Branch):—Annual dinner.

JANUARY 14.

Institute of Metals (Scottish Local Section):—Open discussion at Glasgow.

JANUARY 15.

Institute of Marine Engineers:—Ordinary meeting in London adjourned. Discussion on "Superheating."

JANUARY 16.

Institution of Production Engineers:—General meeting in London. "Accuracy in Production Engineering," Paper by J. E. Baty and A. J. C. Brookes.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT, 1923-24, Oliver Stubbs, M.I.Mech.E., Openshaw, Manchester.

LIST OF SECRETARIES—

General Secretary: W. G. Hollinworth, 38, Victoria Street, London, S.W.1.
Lancashire: T. Makemson, 21, Beresford Road, Gorse Hill, Stretford, Manchester.
Birmingham: H. James Roe, 33, Herbert Road, Bearwood, Birmingham.
Sheffield and District: W. A. Macdonald, 62, Bannerdale Road, Sheffield.
Scottish: W. H. Bound, 69, Minard Road, Shawlands, Glasgow.
London: H. G. Sommerfield, Woodhouse Road, N.12.
Newcastle-on-Tyne: H. A. J. Rang, 2, St. Nicholas Buildings, Newcastle-on-Tyne.
East Midlands: H. Bunting, 17, Marcus Street, Derby.
Coventry: J. M. Meston, 37, Melville Road.
West Ridings of Yorkshire Branch: A. Love, 232, Gladstone Street, Bradford.

Welsh Engineers' and Founders' Association.

Secretary: E. J. Griffiths, 20, Fisher Street, Swansea.

Mould Gases.

It is a little disappointing to read from some of the discussions which have taken place before the various Branches of the Institute of British Foundrymen that many foundrymen do not yet realise the function of coal dust in moulding sands. It can only be useful in that portion of the sand which becomes heated above the coking or ignition points; beyond those it serves no useful purpose. Its main object, as we see it, is to take care of the free oxygen existing in between the pores of the sand, and ensure a film of non-oxidising gas in between the mould and the metal. If an oxidising atmosphere is created, it may burn the iron of the metal to ferrous oxide, and this being nascent and active, is likely to unite with the silica of the sand and form a slag. This would weld the sand on to the metal, and so increase the work of fettling. Beyond the evolution of such gases as methane and other inflammable gases, the action of coal dust is much the same as charcoal, plumbago and graphite. The differentiation between plumbago and graphite is one that does not appeal to us. There are but two factors worth considering, the first being the ash content, the second the superficial area, or, in other words, the state of division. The character of the ash may have a very minor influence. The carbon, whether mixed with the facing sand or dusted on the surface, and whether it exists as coal dust, graphite or other material, has exactly the same function, namely, that of caring for any free oxygen present, and preventing the extensive formation of ferrous silicate. As it creates gas and occupies a minimum of space, we cannot visualise it as an aid to venting. This will be better understood when it is realised that the products of combustion occupy much more space than the material burnt.

Mr. E. Longden, in his most interesting Paper which appears elsewhere in this issue, hazards a reaction between mould and occluded gases. We suggest as an alternative that steam blowing in from a core or a projecting part of the mould is reduced by the carbon in the metal to hydrogen and carbon monoxide. This reaction would be endothermic, or one which requires heat for functioning, and so would cool down the adjacent metal and thus be unable to escape. However, as we know so little about high-temperature chemistry, it is difficult to be dogmatic, but any theory, if reasonable, and which will help practical men to make better castings, is welcome. Mr. Longden's suggestion may be correct, and in order to advance matters it may be advisable to assume some factors so that each one of us can bring our reasoning powers to bear. Primarily, the gases in the metal are assumed to be in solution, or are in position to be expelled if evolved. Further, they are presumed to consist of hydrogen, nitrogen, and carbon-monoxide. The mould and core gases may be thought of as consisting of air (one-fifth oxygen and four-fifths nitrogen), carbon-monoxide and steam. Any reactions between gases which created heat would in all probability move from their place of combustion, but a reaction which requires heat would be likely to stay *in situ* and leave its traces. It is for this reason we suggest the reaction between the carbon in the metal and the steam from the sand. The Paper referred to should be studied by every technical foundryman, and, where possible, the experiments should be repeated to confirm or reject. If general confirmation can be found, they would be of the greatest help in formulating a definite basis for the systematic production of sound castings and the elimination of experimental castings.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Decline of Semi-Steel.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—With reference to Mr. Campion's letter I cannot allow his statement regarding myself to pass without comment.

He states that he cannot agree with me because I suggested that "the conditions for successful melting of semi-steel are greatly different from those required for melting special pig-irons." I did not say this. What I said was that some special knowledge and experience were necessary in order to make semi-steel satisfactorily, and where this was not available it was not surprising to find the special pig-irons receiving favour. Mr. Campion's letter suggests the use of a separate cupola for semi-steel, and goes on to say that trade conditions do not always allow of this, and "in many cases explain the relatively small output of semi-steel, the founders preferring to use the better grade pig-irons for the smaller melts of high strength castings and use only one furnace." In my experience I have not found it necessary to use a separate cupola for semi-steel, and, if it were so, then I am sure the material would be ruled out of court in many cases, as it evidently has been in the cases mentioned above. All of this points to the fact that in order to melt semi-steel successfully in the ordinary cupola, along with other mixtures of various kinds, a certain amount of skilled control is necessary if the best results are to be obtained.

Yours, etc.,

ERNEST WHEELER.

Manchester, January 5, 1924.

Catalogues Received.

Heat Treatment of Steel.—"Some Considerations of the Selection of Material and Heat Treatment for Tools," by A. R. Page, constitutes Heat Treatment Bulletin No. 31, issued by Messrs. Automatic and Electric Furnaces, Limited, of 173, Farringdon Road, London, E.C.1.

Metallurgical Furnaces. — Messrs. Smeeton Wright Furnaces, Limited, of St. Stephen's House, Westminster, S.W.1, have sent us a catalogue of real interest for foundrymen, as it describes some novel heating and melting arrangements for foundry work. Two distinct systems are described, one being the application of "Multiflame" for melting purposes, and the other the "Rotary-flame," which is used for annealing and heat treatment. This system has recently been applied to the annealing of malleable iron.

Supplementary List of Calendars, etc., Received.

We have received from **Messrs. Broad, Salmon & Company, Limited**, Windmill Street, Tottenham Court Road, London, art metal founders, an aluminium match stand. Calendars have been received from **Messrs. Beecroft and Partners, Limited**, St. Peter's Close, Sheffield, consulting foundry and analytical chemists (this contains illustrations of their chemical laboratory, test house and experimental foundry; from **Mr. H. G. Sommerfield**, Hanthorpe, Woodhouse Road, London, N.12, and from **Messrs. Joseph Henry, Limited**, Manor Road, Leeds, iron founders. **The Clay Cross Company, Limited**, of Clay Cross, near Chesterfield, have sent us a diary, which in addition to containing illustrations of the works, also includes much useful foundry data.

AT AN INQUEST on Mr. J. A. Faulkner (67), held in Hersham Coroner's Court, Mr. Vivian Faulkner, iron founder, said his uncle, who suffered from nerves, placed his head on the anvil of a 50-ton electrically-driven hammer.

RITCHIE, HART & COMPANY, LIMITED, of the Mountpottinger Foundry, Belfast, have received an order from Harland & Wolff, Limited, Belfast, for one of their patent core-making machines, electrically driven, and suitable for cores 20 ft. long x 24 in. diameter and smaller sizes, for installation at the latter Company's Belfast foundry.

Foundry Queries.

Facing Sands for Ornamental Castings.

With reference to the query bearing the above caption, I would suggest in this case that a mixture of old sand with Mansfield sand, in the proportions of 5 Mansfield to 1 of old, would make a facing suitable to "G. A."

These sands should be thoroughly mixed, and a sieve of 16 meshes to the inch should be used in covering the pattern. After the pattern has been drawn, a liberal dusting of *fine powdered charcoal* should be given, the patterns put back carefully and gently tapped so as to face the mould lightly with the charcoal; all surplus charcoal can then be blown off.

Ordinary drying in an oven until the mould is dry is all that need then be done, with a careful cleaning of the mould in assembling.

Mansfield sand and charcoal for this purpose can be obtained from any foundry supply concern.

G. C. P.

[Offers of help have also been received from Messrs. T. Singleton, of the General Refractories Company, Limited, of 28, Blonk Street, Sheffield, and G. C. Swift, of 31, Charlton Avenue, Trafford Park, Patricroft, Manchester, the latter of whom requires the following information:—Class of work; thicknesses of sections; faintly or deeply engraved; present type of sand used; position and dimensions of stove, and size of boxes.—EDITOR.]

Tellurium in Steel.

Dr. G. B. Waterhouse and I. N. Zavarine, in a recent issue of the "Iron Age," detailed some experiments they have made on the properties of steel containing tellurium. They summarise their results in the following statement:—

A careful examination of a steel containing 0.12 per cent. tellurium shows the presence of a non-metallic constituent that is probably a telluride, closely associated with manganese sulphide. When the steel is forged this telluride does not break up but elongates fully as well if not better than manganese sulphide. The steel is low in ductility than normal material without the tellurium.

The results would indicate that it might be well to investigate the influence of tellurium in regard to the free cutting or free machining properties of the steel, to see whether this element could be used instead of sulphur for that purpose.

I.B.F. Propaganda Meeting.—As announced in our last issue, a meeting will be held at the South Wales Institute of Engineers on Saturday, January 26, at 6 p.m., in order to explore the possibilities of inaugurating a local branch of the Institute of British Foundrymen. Mr. J. J. McClelland is acting as honorary secretary, and the president, Mr. Oliver Stubbs, is to take the chair. Mr. McClelland is to read a Paper on "Shrinkage and Warping in Iron Castings." It is to be hoped that Welsh foundrymen will make a serious effort to be present, as a splendid opportunity is afforded to bring themselves into line with the other important foundry areas of Great Britain.

Tube Segment-Castings Order Placed.—Messrs. Cochrane & Company, Ormesby Ironworks, Middlesbrough, have secured the contract, amounting to over 60,000 tons, for the whole of the cast-iron tunnel plate segments for lining the City and South London Railways Wimbledon Tube. The firm have also secured the order, involving over 4,000 tons, for approximately 6½ miles of 24-in. cast-iron pipes for the Tees Valley Water Board's Aqueduct No. 14.

American Foundrymen's Association: 1924 Convention.—The board of directors have unanimously voted to return to the practice of holding autumn meetings, a custom departed from in 1921, when because of certain conditions it was decided to postpone the annual meeting of that year until the spring of 1922. The Board were also unanimously in favour of meeting in some city west of Cleveland, as the only meeting held in that section since the Chicago Convention in 1914 was at Milwaukee in 1918. In 1923 the Association has added 236 new members.

Book Reviews.

Mechanical Stoking. By David Brownlie, B.Sc. Published by Sir Isaac Pitman & Sons, Limited, Parker Street, Kingsway, London, W.C.2. Price 5s. net.

This is a double volume of one of Pitman's Technical Primers, many of which have been reviewed in these columns. Beyond making the castings the average foundryman does not worry much about the mechanical stoking of boilers, and he would do well to read this work. The foundryman has problems allied to some of those dealt with, such as the transport of sand and the continuous drying of cores. The book is divided into six chapters, one of which, Chapter V, is of interest to our readers, as it deals with the mechanical handling of coal and ash.

Materials, and their Application to Engineering Design. By E. A. Allcut, M.Sc., and E. Miller, M.I.Brit.F. Published by Messrs. Charles Griffin & Company, Limited, of Exeter Street, London, W.C.2. Price 32s.

We are unable to account for the fact that we received the impression from the title that the book would be devoted to the testing of materials. However, this is not the case, though, of course, this phase of the subject preponderates. One of the authors is professor in the University of Toronto, whilst the other is associated with the Incandescent Heat Company, Limited, of Birmingham, and the combination has proved a happy one. The subject is dealt with in a practical manner, but in an order opposite to that which the title suggests. Candidly, we do not like the arrangement. To read about the microstructure of cast iron in Chapter IX and its general characteristics in Chapter XIV does seem like putting the cart before the horse. As the authors state that the book is written for engineers, this aspect assumes importance, because if it was meant as a metallurgical treatise the authors would have reason to assume that readers were *au courant* with each phase. However, the book will be of great interest for the foundryman, whose training has been more on the engineering side of his profession. The statements contained in it are quite orthodox, and the fullest reference is made to the various authorities who are extensively quoted.

The work is divided into 20 chapters, and is made up of about 500 pages, which are illustrated by 221 photographs and drawings.

International Register of Telegraphic and Trade Addresses. Published by Messrs. International Code Company, Limited, Marconi House, Strand, London, W.C.2. Price 52s. 6d.

This book contains within the compass of 2,100 pages full details of 70,000 of the principal firms of the world indexed in three main sections: (1) Alphabetical list of business firms, with full postal and cable address of each, nature of business and code used; (2) classified trades list, showing the principal firms throughout the world engaged in any given trade; (3) an international cable address index.

In addition, an ingenious yet simple coding system is embodied whereby it is possible to mention firms, goods, services, etc., in telegrams and cables at exceptionally low cost. One of the great advantages of this coding system lies in the fact that it can be used in conjunction with most standard codes.

The Register has been arranged throughout for quick reference, and examination shows that it contains not only the most accurate information obtainable, but that it is possible and easy to find who are likely buyers of goods in any given country; which firm uses a given cable address; which firms in various countries can supply given products; what is the cable address of a particular firm and what codes they use; what the correct designation, address or business of a specified firm may be, etc., etc. The Register is thus a self-contained publication, and will enable importers and exporters of all countries to get into business communication with each other in the effort to develop international trade. Business men would be well advised to take an early opportunity of examining this important work of reference.

Iron and Steel Trade between Great Britain and Sweden.

In the course of a lecture delivered by CONSUL-GENERAL E. G. SAHLIN, before the Anglo-Swedish Society recently, he stated that the reputation enjoyed by Swedish iron and steel depended not only on the purity of its ores, but also on the fact that charcoal was used for the blast furnaces. With the growing introduction of coke in the manufacture of pig-iron Sweden gradually lost its quantitative position. In 1740 they manufactured 40 per cent. of the total world's production of pig-iron, and, in fact, Sweden produced, between 1720 and 1740, twice as much pig-iron as Great Britain, and as late as 1780 its output was greater, and the largest in the world. The introduction in Great Britain of the puddling process in 1784 made it possible to employ coke-smelting on a large scale. Already, in 1790, England had passed Sweden in the production of pig-iron. In 1800 Sweden's part in the world's production of pig-iron had shrunk to 13 per cent.; in 1850 it was reduced to 3 per cent., and just before the war it did not produce more than 1 per cent. This did not mean any reduction in output, and as far as quality was concerned Sweden still maintained its unique position, but the figures in question indicated the enormous increase in the production of coke-smelted pig-iron and steel manufactured from it.

Continuing, the speaker remarked that centuries before the Swedish ore deposits in Norrland had been exploited, the famous Dannemora iron formed an important component in the manufacture of steel in Great Britain, but it was only after the introduction of the Huntsman process that the Dannemora iron reached the position which it still held in Sheffield steel-making. Owing to the high quality of the Swedish ore and the high cost of charcoal, it did not pay Sweden to use their own mild steel for a great number of requirements, principally structural work. Accordingly, while they send about 100,000 tons of pig-iron and 100,000 tons of iron and steel to the United Kingdom every year, they bought about 120,000 tons of various products from British rolling mills and blast furnaces.

English capital was instrumental in the opening-up of the most important Swedish iron-ore deposits. When the Frövi-Ludvika railway, otherwise the Swedish Central Railway, was built, plans were formed to work the important Grängesberg area. Professor Forbes, a British expert, was engaged, and gave a report upon the ore deposits. Nothing was, however, done until towards the end of 1880, when the assistance of the famous British financier, Sir Ernest Cassel, was secured. A consortium was formed, in which another British participant was Fredrick Warburg. The Grängesberg mining company was formed in 1881. Exportation of ore commenced in 1882, but an output of 100,000 tons was not reached before 1891. Cassel was instrumental in increasing the capital of the Grängesberg concern, and also in the acquisition of the great ore fields in Norrland in 1903. About ten years later he disposed of his holdings in this company. The bulk of the Norrland ores went for a number of years to the Continent, but in 1900 the United Kingdom imported some 100,000 tons, a figure which ten years later had increased to nearly 600,000 tons.

An Iron and Steel Cinema Film.—Messrs. Dorman, Long & Company are giving a lead in the way of enlisting the services of the cinema in the business of their extensive undertakings. For the British Empire Exhibition they have prepared a film of great interest to those engaged in the production of iron and steel. The progress of the iron, from the extraction of the ore to its appearance either as wire, plates, or girders, is graphically shown. The quarrying of the limestone, the mining of the ironstone in Cleveland and of the coal in Durham, the conversion of the coal into coke and the extraction of the by-products, the smelting of the ore, the manufacture and rolling of steel, the drawing of wire, and the work of steel construction are all illustrated in such a way as to bring out clearly the details of the different processes. The film takes half an hour to show. A private exhibition has been given at Middlesbrough for the benefit of the officials and staffs of the Company.

XUM

The Iron and Steel Industry of South Africa.

By J. H. Holden, M.I.Brit.F.

The chief consumers of iron and steel products in South Africa are the Rand gold mines and the railways. Annually the imports of rock drill and jumper steel, shoes and dies, tube mill bars, castings, forgings, etc., amounts to hundreds of thousands of tons.

Johannesburg, the centre of the gold reef, is practically four hundred miles by rail from the nearest port; hence the freightage and rail charges make the imported articles very costly. In addition, there is the time factor, which, in the case of replacements (particularly for breakdowns), is a serious item.

Although there are very large deposits of iron ore, extensive coalfields, and an abundance of refractories, the smelting of pig-iron has only been attempted spasmodically. In Pretoria, efforts have been made to establish an iron works. The extensive ore deposits adjacent to the capital were the source of the raw material—contrary to the usual custom, fuel was transported to the ore fields.

A very ambitious scheme was projected in Newcastle (Natal). Here the plant was to be a self-contained works, comprising coke ovens, blast furnace, and a steel furnace unit. This scheme was apparently attempted with insufficient capital. Now that the Pretoria, Newcastle and Vereeniging Companies are merged into one, it is possible that South Africa may become a pig-iron producing country.

Coal Carries High Ash Content.

The coal in South Africa, as a rule, carries a high content of ash. There are, however, seams which do not come within this category. Tests made by the South African Railways and Harbours Stores Department, in 1920, showed that Bernica (Natal) coal contained 8.8 per cent. of ash and 1.3 per cent. of sulphur. The Government Commission Report gives for the same coal 10 per cent. of ash. This colliery, it may be added, has a large beehive coking plant, and their product is a good type of furnace coke. The analysis shows that it compares very well with English foundry coke; the sulphur runs about 0.6 per cent., with an ash of 10 per cent.

Iron Foundry Raw Materials.

Since there is no manufacture of pig-iron, the requirements have to be imported (though pig-iron is not always considered an essential for much of the work done in the iron foundries)—statistics show the little that is used comes from Great Britain and India. On the Rand the source of the raw material for the foundries and iron works is scrap, the accumulations of years of working of the gold mines. There are many iron foundries running entirely on scrap iron. Similarly the wrought iron made is a product of scrap. In this case, mild steel and wrought iron scrap are piled, shingled and rolled. Needless to say, specifications are not very rigid, and composition is rarely mentioned.

In iron foundry practice this continual concentration of impurities caused by using 100 per cent. scrap charges is bound to give rise to serious difficulties; furthermore, the deterioration due to oxidation following repeated melting also leads to unsoundness. Any foundryman who has used worn-out hematite steel ingot moulds knows full well the effect of oxidised iron in his castings. The writer came across some gears (made in a Johannesburg foundry) which had a very high sulphur content, 0.18 per cent., with only 0.23 per cent. of manganese. It is perhaps not surprising that they gave very poor service. From one point of view, the Rand iron foundries are in a unique position. Because of the difficulty in securing steel castings locally and the delay in importing, iron castings are used considerably as substitutes for steel. Unless South Africa produces her own pig-iron for foundry work, it appears likely that India, because of its favourable geographical position, will supply pig-iron in greater quantities.

Electric Furnace Shows Prospects.

There are a few electric steel furnaces in operation, and there can be no doubt that future developments in the steel foundry will take place in this direction. The small furnace of from 1 to 2 tons, which can be worked with the minimum of European labour, is undoubtedly an economical plant to operate, not only for steel castings, but also for such articles as tube mill bars, and although special alloy steels might give much better service for tube mill bars, the high carbon steel fairly high in manganese (C. 0.9 to 1.0 per cent. with Mn 0.9 per cent.) has given very satisfactory results. Steel of this composition can be made in electric arc furnaces very successfully, and it is doubtful whether any other process could compete with it. Before this material is turned out on a tonnage basis, however, there must be developments in rolling mill practice.

Power for electric furnaces is available from the Victoria Falls Power Company. Contrary to the hydro-electric suggestion of such a title, the whole of this Company's power is generated from coal. There are stations at Brakpan, Simmerpan, Rosherville, Germiston and Vereeniging, and a new station in course of erection in the Transvaal coalfields at Witbank. Overhead transmission of the H.T. current is employed. In consequence, during the very violent thunderstorms, breakdowns sometimes occur; but, in all fairness, it must be stated these are very expeditiously dealt with, and they should hardly affect the manufacturing costs of a steel foundry.

Water Supply Difficulties.

Water supply is a very thorny problem, for the country is almost devoid of good rivers. Many of the so-called rivers of South Africa are dried up for months at a time. The rainfall, which occurs entirely during the summer months, comes in violent storms, rapidly disappears, and even after a very heavy fall the ground is dry within a couple of days. Further, during five or six months of the year no rain falls. Thus water on the Rand, in the quantities used in manufacturing processes, unless it can be pumped on the property, is a very costly item.

It is doubtful whether an iron and steelworks, meaning by that term a combination of blast furnace plant, steel furnaces, mills, foundries and forges, will be successfully established near the Rand mines. Vereeniging appears to be the most likely place, as it is only 49 miles by rail from Johannesburg, and railway lines also radiate to Pretoria, Witbank and Bloemfontein. Near by is the Vaal River, where vast schemes have been undertaken to conserve the water. There is, of course, an established steelworks in the district, and this, as already mentioned, is linked up with the Newcastle and Pretoria schemes, so further development may be expected.

So far as the writer could learn, difficulty has been experienced in finding a naturally-bonded sand sufficiently refractory for steel foundry use. Following American practice, artificially-bonded siliceous sands have been successfully used. Loamy sands suitable for iron foundry practice are very plentiful, and in many places can be obtained simply by paying for the cost of digging and carting.

In lieu of "silver" sand for furnace work, the writer used coarse quartz sand from an old mine dump, which had weathered for some years and become free from sodium cyanide compounds. This material proved to be very refractory. It was also used as a parting sand.

OUT OF THE 39 FURNACES in the Grand Duchy of Luxemburg, 28 are in blast. The Arbed concern's general meeting was held recently. The report for the financial year 1922-23 shows gross profits of nearly 34,485,300 fcs., which, with the amount brought forward from the previous year, represents a total of over 34,511,400 fcs., against nearly 28,152,300 fcs. in the previous year. After making sundry appropriations, 120 fcs. per share is to be distributed. The Arbed concern has a community of interests with the Compantria Siderurgica Belgo-Minera in Brazil and the Societa Talleres Metallurgicos in the Argentine.

Relative Values of Feeders or Denseners in Grey Iron and Malleable Iron.*

By E. Longden, M.I.Brit.F.

The subject matter of this Paper is obtained from works practice and experiment. Two classes of iron are dealt with—white, which is subsequently annealed to produce either Reaumur or black heart malleable iron castings, and the more commonly-used grey iron for general castings. A comparison is made of the merits of feeders and denseners; also, in the course of the experiments, a comparison is made between white and grey iron treated in the same way and poured into the same form of mould. Such a procedure helps to demonstrate a definite result rather than trust to general deduction. Although not quite in line with the title of this Paper, much evidence will be given showing the effect of gases in producing unsoundness principally in grey iron.

White and grey iron act very differently on cooling from the liquid to the solid, and to produce sound castings in each class of metal, different feeder and runner gates are applied. A sound casting is very often easily obtained in grey iron which presents much difficulty in white iron.

White Iron has Shorter Freezing Range.

Ordinary foundry grey irons contain large quantities of silicon and carbon; these elements together are mainly responsible for the softening of cast iron. With the exception of sulphur, white iron holds smaller amounts of the common impurities

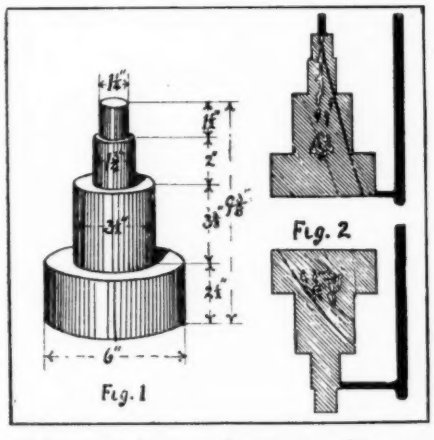


Fig. 1

Fig. 2

found in grey iron, and consequently possesses a shorter fluid life.

The dissociation of the iron carbide when grey iron cools provides compensation for liquid shrinkage. Only a trace of carbon is precipitated when white iron cools, the bulk remaining in combination, and consequently there is more liquid shrinkage.

The principle factors which govern the rate of solidification in cast irons are:—Degrees of superheat above melting temperature and freezing point as determined by composition. The amount of combined carbon governs the melting temperature and higher the total carbon, the longer the period of cooling. It is generally accepted that, in melting grey iron, the graphitic carbon must first be dissolved before fusion point is reached, which results in a considerable amount of heat being rendered latent, and is stated to be equal to a superheating of about 270 deg. C. The melting temperature of grey iron is given as 1,250 deg. C., and that of white iron about 1,120 deg. C. Silicon, by reducing the stability of iron carbide and compelling carbon to precipitate, generates heat and prolongs the life of the molten metal, so that grey iron freezes at a lower temperature than its melting point.

Liquid Shrinkage and Gas Holes.

Many foundrymen and metallurgists state that they can distinguish the difference between a gas hole and liquid shrinkage cavity. Personally, the author admits that he has never been too sure,

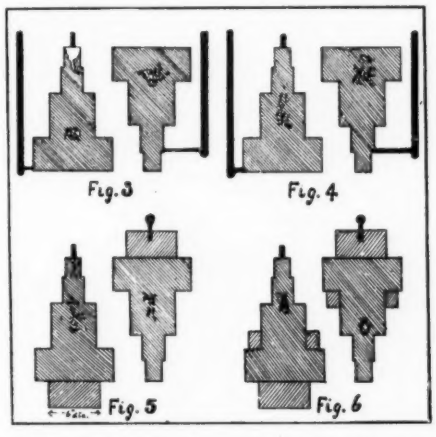


Fig. 3 Fig. 4 Fig. 5 Fig. 6

especially with grey iron. Blow holes from cores and moulds sometimes show up very clearly; blow holes from occluded gases are not certain.

Methods of Feeding Short Chills are Preferable.

To obtain sound castings, feeding is resorted to. In grey iron, feeding is accomplished in several ways, the most common of which is pumping with a wrought-iron rod inserted in the riser heads mainly, and runner gates. Sometimes the gates are subjected to a pumping movement obtained by placing sand on the metal in the runner basin, using a spade with an up-and-down movement until the motion of the metal in the riser ceases, the object being to keep the metal moving on the top side of the mould, thereby preventing it solidifying before the metal below. In other cases fluidity of the metal is prolonged by additions of hot iron to riser and runner heads. What are termed self-feeding heads are fixed on certain types of castings. In many cases the latter method is preferred rather than risk the often unintelligent use of the feeding rod. When feeding a heavy section, hot metal is supplied from time to time. In very heavy castings fed over a long period, a reserve number of loose riser bushes are provided, so that when the metal in the head congeals from the outside, restricting the movement of the rod, the whole bush, with its

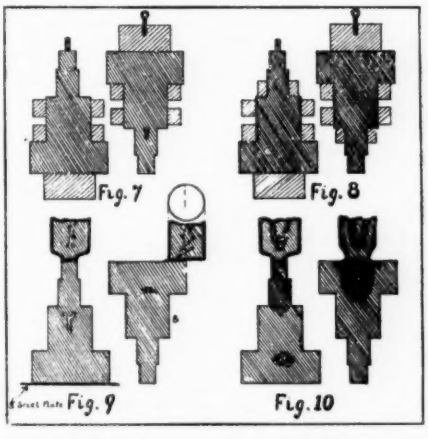


Fig. 7 Fig. 8 Fig. 9 Fig. 10

solid and solidifying metal, is torn off and a new bush substituted, which is then filled with hot iron.

In white iron, large self-feeding heads are applied both inside and outside of the mould. Considerable skill is needed to locate the feeders.

D

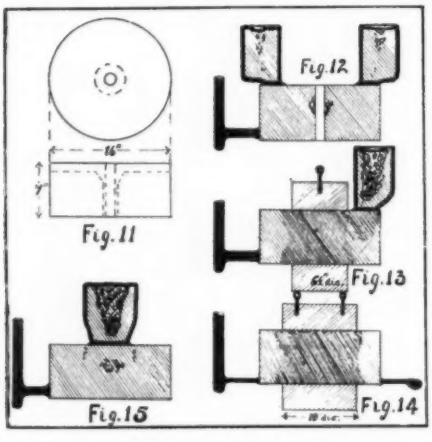
* A Paper read before the Birmingham and Sheffield Branches of the Institute of British Foundrymen.

Shapes of runner and feeder heads have so often been dealt with that they will only incidentally be referred to.

Small pieces of solid iron are inserted inside and outside of moulds to shorten the period of cooling and prevent the formation of cavities in sections which are prone to defects.

Short Chills are Preferable.

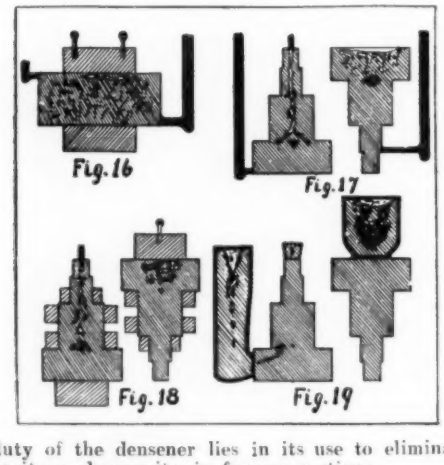
Irregular thin plates of large area can be kept straight by building in the mould short lengths



of cast iron or steel, placed judiciously so that the rate of cooling is hastened diagonally, crossways and in the centre. Care must be exercised in placing such chilling pieces. (In such cases, the term chill might be used, as the object is not to densen the metal, but to obtain a more uniform contraction.) When used for such a purpose, chills should be made in narrow lengths. If long pieces are built in the mould, the side of the chill in contact with the molten iron will expand more rapidly than the reverse side whilst the iron is still molten; consequently the convex surface thus formed leaves the level of the mould face and rises into the metal, producing a scrap, or at best an unsightly casting. Even with the greatest care the mark of the chill is very evident, and unless the chilled side of the casting is out of sight when erected, such a process cannot be strongly recommended.

Chills and Condensers.

Chills are also used to equalise the rate of cooling between heavy and light sections to prevent fracture and distortion. Denseners are used to improve and close the grain of wearing surfaces in various important castings, but the principal



duty of the densener lies in its use to eliminate cavity and porosity in ferrous castings.

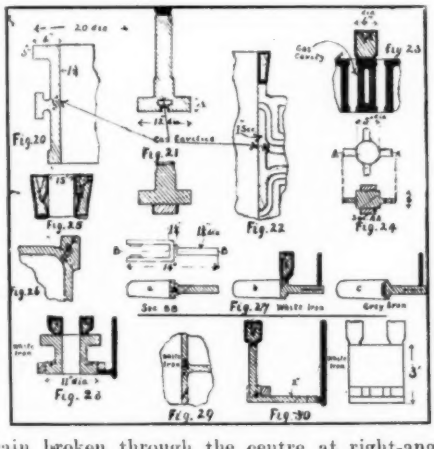
Occlusion of Gases in Metals.

It is generally understood that most of the porosity and cavity in grey and white iron is caused by liquid shrinkage. The author believes Mr. J. E. Fletcher is responsible for the statement that "feeding is necessary to facilitate the escape of occluded gases." At a meeting of the Faraday Society, held on November 18, 1918, an exhaustive discussion took place on the occlusion of gases by metals. Mr. P. Peakman there stated that he "was inclined to think that cast iron does occlude certain gases, and some of the failures which there seems some doubt as to their cause are possibly due to these occluded gases desiring to escape or interact on the constituents of the iron." Dr. Hatfield then stated that:—"The high percentage of silicon normally present in grey cast iron enables it to take care of the gases which could possibly be absorbed under melting conditions. In my works experience I do not remember seeing cast iron containing blow-holes due to occluded gases if the silicon content was over 0.3 or 0.4 per cent., and silicon is always higher than that. Blow-holes in cast iron are almost invariably due to what the foundryman calls trapped air; that is, the mould has not been made in a proper manner or it is a damp mould."

For the moment it is sufficient to state that the following experiments lead the author very strongly to believe that gases produce cavity and porosity in grey iron and gases and liquid shrinkage are together responsible for cavity and porosity in white iron.

Experimental Procedure.

Fig. 1 represents an experimental block casting designed to give a maximum of gas or liquid shrinkage cavity with a view to discovering the cause and the best way to eliminate the defects found. The casting weighs about 28 lbs. Where one section meets another, the corners were left sharp and square to facilitate easy breaking of the blocks into distinct sections. Each piece was



again broken through the centre at right-angles to the previous fracture. The second fractures were obtained by crushing in the jaws of a hydraulic press. This was accomplished by placing the piece of casting on a V block and then holding a triangular rod of steel over the top of the piece to be broken and then subjecting to hydraulic pressure. A neat fracture is obtained, and all vital spots of the casting disclosed.

With one or two exceptions, the blocks were poured in two positions for each test, one with the small end up and the other large end up.

The following is the approximate analysis of the grey iron poured into the block moulds:—Si, 2.5; Mn, 0.3; S., 0.09; and P., 0.9 per cent.

Fig. 2 shows what was disclosed after the first attempt. The moulds were made in green sand, bottom poured, and all ordinary precautions exercised to secure a good casting except that no effort was made to feed. The result at once opened up an interesting field for further experiments. Did not the formation of the cavities show distinct outlines of gas streams, especially in the block cast small end up? In the block cast large end up, the cavities are collected in the centre, where the two heavy parts meet.

Small Runners Reduce Cavities.

Two blocks were then poured, each through a ¼-in. dia. pencil gate, as seen in Fig. 3. There is certainly a reduction in the extent and change in the position of the cavities. The next two blocks, depicted in Fig. 4, were poured in thoroughly dried moulds. The amount of cavity

compares very favourably with those run through pencil gates. Fig. 5 shows the effect of applying a 4-in. densener to the centre of the heavy part of the casting. It is interesting to note that the cavity is reduced.

Two additional half-circular denseners were placed about the neck of the heavy sections when making the next two moulds. Defects are again reduced and moved to the positions as shown in Fig. 6.

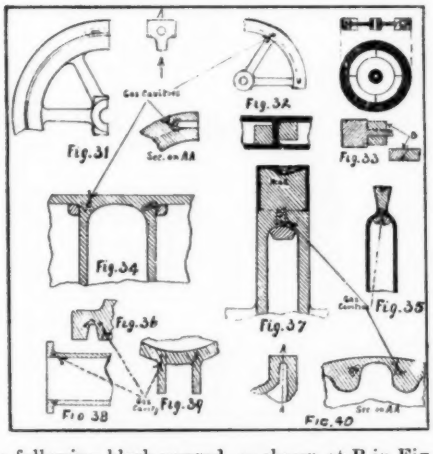
Another pair of denseners was added, which resulted in a further diminution of the cavities, as depicted in Fig. 7.

A third pair of denseners was then applied in the position shown in the next illustration, Fig. 8, giving a perfectly sound close-grained casting throughout. A pair of castings made from an iron mould also gave a similar result. In the last two tests with soft phosphoric iron, a small area about the size of a threepenny-piece, of open-grained structure, appeared in the centre of the juncture of the two heavy parts. When the silicon and phosphorus were reduced to below 1.6 and 0.6 per cent. respectively, a very close-grained structure was obtained even at this vital spot.

With a view to excluding mould gases from the bottom side, an ¼-in. iron plate was inserted in the mould, as depicted at A in the sketch, Fig. 9. A riser gate, the same size as the small end, was carried through the mould and a basin of iron provided to act as a self-feeder. Defects were not so pronounced as in the first test, the plate having excluded some of the mould gases which had previously escaped upwards through the metal.

Feeding Experiments.

A half-circular self-feeder was then applied in



the following block poured, as shown at B in Fig. 9. Only a small defect is disclosed, showing that the heavy feeder had maintained a hot passage for the occluded and mould gases to pass out.

Fig. 10 illustrates unsoundness with rod feeding. When poured and fed small end top, a large cavity was found in the bottom heavy section. With the heavy end top, as will be expected, a more sound casting is obtained, but the result is not quite satisfactory; small gas holes appear under the outer edges of the feeding head, with the usual disturbed crystallisation.

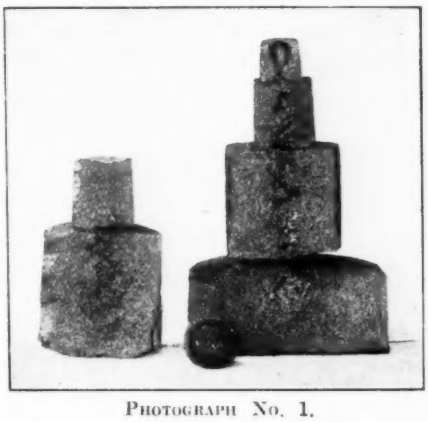
Absence of Mould Gases gives Sound Castings.

Later the author came to the conclusion that a sound casting might be obtained if all or most of the mould gases were prevented from entering the molten metal. Moulds were constructed in plumbago bound together with a small proportion of core gum, thoroughly dried and gated in the same manner as the earlier attempts. Perfectly solid castings were secured, the grain of the iron being a little closer than those cast entirely in green sand. Well-dried ganister moulds also gave a very sound, but much closer grained, casting.

A number of photographs were taken of the cross-section of these experimental block castings. No. 1 shows one of the first castings poured into a green sand mould without any feeder. The second is a photograph of the sound casting finally obtained by a progressive application of denseners. It might be here noted that the denseners were loose and, except the one on the heavy section, in halves and free to be pushed back into the sand when the grey iron expansions take place on cooling. Nos. 3 and 4 are sound castings obtained from plumbago and ganister moulds respectively, as described above.

A Further Type of Casting.

Fig. 11 gives particulars of another experi-

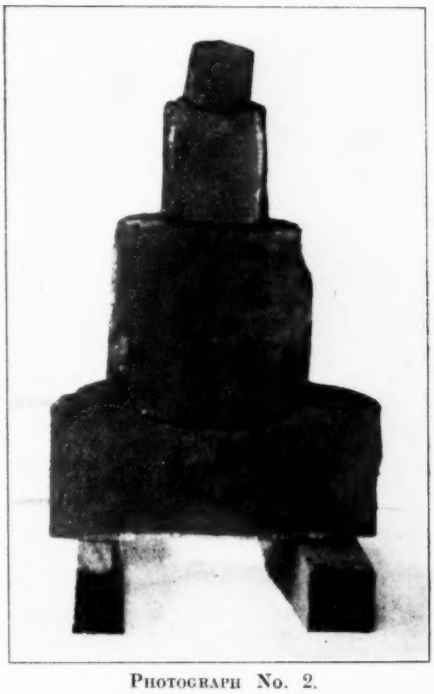


PHOTOGRAPH NO. 1.

mental block casting weighing about 3¼ cwts. An apparently simple casting, but most foundrymen appreciate the difficulty in securing a definitely sound casting by ordinary moulding methods, especially if it is to be machined all over and through the centre, as depicted by dotted lines in the sketch

The first castings produced had a sand-cored hole through the centre; they were bottom poured and two heavy self-feeders located, as shown in Fig. 12. A large cavity was disclosed about the centre core and a little towards the top side. A similar cavity was experienced when the central hole was formed by an iron core or densener. A block cast without core, riser or feeder gave a slightly larger cavity. Fig. 15 shows a casting fed through a 6-in. riser and head, but this was again defective.

A passable casting was secured by applying 6-in.



PHOTOGRAPH NO. 2.

denseners to the centre of the mould, one top and one bottom, and a feeding head situated as shown in Fig. 13.

Fig. 14 shows the same casting poured through several bottom spray runners without any riser or

feeder whatever. Two denseners, 10-in. dia., were placed in the centre of the mould, top and bottom. A perfectly sound, close-grained casting resulted. Photograph No. 5 shows a piece cut from and across the centre of the casting.

Fortified by the experience gained from the smaller blocks, one of these heavy castings was poured in a plumbago mould without riser or feeder, and secured a sound casting, the crystallisation not being so pronounced as those poured in greensand moulds. Further, a mould made in ganister, thoroughly dried, gave a casting also without any defects and a much denser structure.

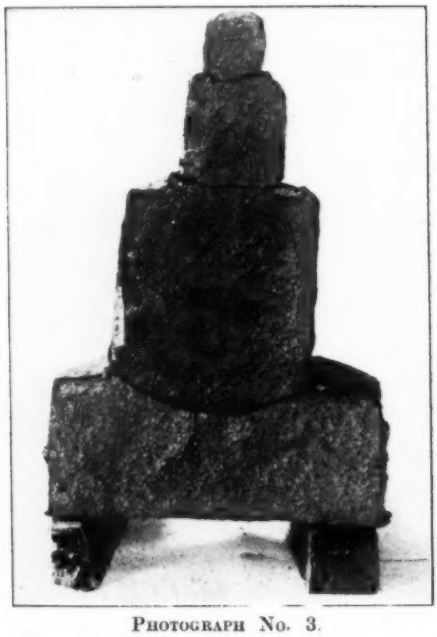
Experiments with White Iron.

Fig. 16 represents a block of white iron, which shows a striking contrast with those made in grey iron and of the same dimensions.

Blocks similar to Fig. 1, made in greensand moulds and not fed, were poured in white iron, and disclosed, as would be expected, much cavity, as illustrated in Fig. 17.

The four sets of denseners, which had proved so effective when applied to the blocks poured in grey iron, did not bring any noticeable improvement with white iron. As will be noted in Fig. 18, the defects are almost as extensive as those poured in green sand without feeding.

Fig. 19 depicts two attempts to obtain a sound casting. The block cast small end up required a large feeder to secure the result shown—only small



PHOTOGRAPH No. 3.

cavities. It is interesting to note that the formation of the defects seem to indicate that the gases have worked down and then up through the feeder head. Pouring the casting large end up, with a 3-in. riser gate and a self-feeding head, resulted in a sound casting.

If some of the common defects found in ordinary and important castings are examined, whether poured in iron low or high in those elements or impurities which constitute cast iron, much will be learnt from the experiments just described.

Gas Cavity Defects Illustrated.

From the group of drawings illustrating sections commonly experienced with defects which are usually explained as liquid shrinkage holes, it is suggested that they are, with grey iron, in every case, gas cavities.

Fig. 31 shows a section of a heavy half-flywheel. Tee-shaped holes are formed in the rim by cores. Sponginess occurring at the nose of the core in spite of heavy rod feeding, was eliminated when a very free core vent was provided.

Gear blanks similar to Fig. 32 give trouble where the arm meets the rim. Gases play off the hot corners of the core. Denseners placed in the cores, as shown in the enlarged section, is the remedy.

At Fig. 33, another type of gear blank is outlined. A very sound and hard-wearing gear is obtained by employing a ring of denseners top and bottom of the web. The denseners are constructed as depicted in the enlarged sections. Only common iron is used for the castings.

Fig. 34 illustrates a section which also gives trouble. Here again gases play into the hot spot formed where the bracket meets the body. Holes formed through the bracket, preferably by an iron core, as described, will prove effective.

Figs. 35 and 37 show defects in small ram and heavy hydraulic cylinder castings. Denseners attached to the cores are employed. If gases are conducted freely away, and the core very carefully made, the denseners are not needed. Fig. 36 is another common defect. Cavity is disclosed when the recess is cleaned up by machining. Figs. 38, 39 and 40 can all be explained in a like manner.

Fig. 20 is a part section of a sleeve casting, which is machined all over. Defects occur about the place where a portion of the mould protrudes into the metal. Such a piece of sand quickly reaches a high temperature and acts as a heat retainer; the grains of sand expand and loosen somewhat, allowing a freer passage for the imprisoned gases in the body of the mould, and unless an easy and clear vent is provided, the gases will flow into and be found in those places last to

PHOTOGRAPH No. 4.

freeze, as indicated in the sketch. A densener placed on the bore opposite the unsound place hastens cooling of the metal, thereby reducing the time that the gases can generate and flow from the sand.

More Defects Explained.

Fig. 21 shows a spindle casting. Sponginess is in evidence at the root of the shaft when the tee-headed slots are machined out. A great depth of head metal would not remove this defect. A densener placed as shown in the bottom section eliminates unsoundness.

Fig. 22 is another common defect—porosity about cylinder ports. Such thin cores act as heat retainers. If the lightening core between the ports is not freely vented, defects as indicated might be expected. A number of small clean nails pushed in the mould or cores about the vital spot generally eliminates such a trouble. Fig. 23 illustrates a similar case. The drawing shows a portion of a Diesel cylinder head.

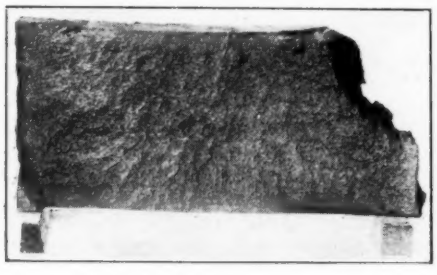
Sponginess in pulley bosses can be eradicated by removing the core and placing denseners both top and bottom, as depicted in Fig. 24. The size of densener should always be less than the diameter of the boss by 1 in. Not only is cavity removed,

XUM

but rate of cooling is much more equalised and danger of fractured castings minimised.

Shrinkage holes in heavy feeding heads with a core running through the centre show up as in Fig. 25. Cavity is disclosed on the core side as well as in the centre of the head section. The core becomes very porous and over-heated at this part, allowing gases to flow freely into the metal there, possibly to react with occluded gases and generate heat in the locality.

Fig. 26 shows a section often encountered in cylinders, etc. After tapping a hole, cavity is found at the root of the boss. A number of small



PHOTOGRAPH NO. 5.

clean nails inserted in the mould so that they do not protrude into the machined portion will overcome this trouble.

In the next example, Fig. 27, of a fork-like casting, a comparison can be made between grey and white iron. "A" is a section showing the position of the cavity when cast in grey or white iron. In grey iron, the defect disappeared when a densener was applied as indicated in the sketch "C." In white iron, the densener proved useless. A sound casting was obtained in white iron by enlarging the section above the troublesome spot and providing a self-feeding head, as shown at "B."

Various Cavities Eliminated.

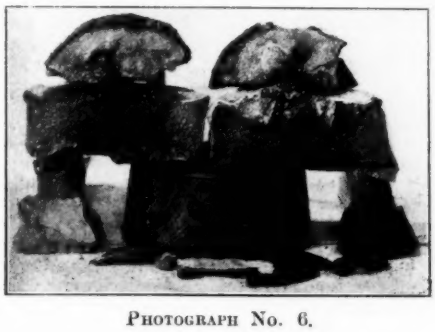
Fig. 28 might represent a double-pinion blank cast in white iron. Here the combination of denseners applied to the blank-cast bottom along with two good feeding heads is necessary to secure a sound casting.

Fig. 29 shows a section commonly met with both in grey and white iron. With white iron, the gases which pass into the hot spot react with occluded gases, probably generating heat and allowing metal to drain away and supply feed to other parts of the casting. Denseners placed in the corners will remove the defect.

An L-shaped casting is illustrated in Fig. 30. The casting is of white iron, and weighs about 4½ cwts. If denseners are not applied to the heavy-section corners, together with good feeding heads, unsoundness and weakness would there be expected.

How to Prepare Denseners.

There are still many foundrymen who are prejudiced against the use of the densener, probably



PHOTOGRAPH NO. 6.

because they have allowed them to be carelessly used. Little trouble need be feared from their use if they are systematically cared for. Flat denseners can be used for a considerable number of times if they are ground on an emery stone each time after using. Denseners to be placed in greensand moulds are quite safe if smeared with oil, followed by an application of dry plumbago, but those to be placed in cores and moulds which are dried should be painted with stiff core oil and dried in a stove before inserting in the sand.

Photograph No. 6 shows a densener which has been used only twice below the head in a heavy casting. This example shows the necessity for casting denseners in low silicon and phosphorus iron, especially the latter. A rapid wasting has evidently taken place. There appears to have been liquation of the phosphide eutectic.

Conclusions.

In commonly-used foundry grey irons, with silicon ranging from 1.3 to 2.8 per cent., and the other elements in proportions usually encountered, defects, excluding distinct mould and core blowholes, etc., as described in this Paper, are caused by trapped mould gases reacting or interacting with occluded gases, probably forming, mainly, carbon monoxide. If mould gases can be prevented from entering the molten metal, a sound casting results, even if poured with dull iron. Although not commercially practicable, castings made in dried ganister or plumbago moulds gave perfectly solid castings. It would also follow that a cavity is not necessarily transferred to another part of the casting when eliminated at a particular part by a densener.

Defects, excluding moulding errors, in white and mottled iron are due to liquid shrinkage and gas inclusions.

Density in grey iron is determined by the rate of cooling and composition. Freedom from cavity and porosity or solidity depends on the absence of mould gases. The solidity of metal poured into iron moulds is due to the above-mentioned combination, and not, as has been stated, to the resistance of the iron mould to the expansions which take place when grey iron cools.

Finally, the author desires to acknowledge his gratitude to the directors of Messrs. Tangyes, Limited, for help and permission to carry out the experiments in their foundries.

Book Review.

A Treatise on Electro-Metallurgy. Fourth Edition. By W. G. McMillan and W. R. Cooper. Published by Messrs. Charles Griffin & Company, Limited, Exeter Street, Strand, London, W.C.2. Price 21s. net.

In the preface to the fourth edition Mr. Cooper states that the section dealing with the application of electric furnaces to iron and steel remains very much as it was in the last edition. The reason he gives for its retention in a practically unaltered form is similar to that he gives for the deletion of the section on electric welding, which was incorporated in previous editions, namely, the growth of an extensive and independent literature. Unfortunately, this is the very section which is of paramount interest for our readers.

This book, for well over a quarter of a century, has been regarded a standard work on the subject, and we appreciate the difficulty of revising and bringing up to date new editions. Probably the best course to pursue is to concentrate on retaining its usefulness as a text-book for students. A time must arrive when a book is regarded as a classic. For instance, Dr. Percy's books, though still useful, apart from their historic value, would be completely spoilt by any attempt at revision. The utility of standard works always remains, but a limit must naturally be placed upon the number of editions it will stand, otherwise it produces an unwholesome mixture of a "period" work and a modern treatise. We suggest that it would have been preferable to produce an entirely new work.

The Report of the Canadian Commission in 1904 on the position and possibilities of the electric smelting of iron and steel, when there were less than half a dozen experimental furnaces at work in England, is of historic value only, and its inclusion in a modern text-book is wearying, but in a "period" book its inclusion is very desirable.

The book, which is uniform with Griffin's well-known Scientific Text-Book Series, is divided into 20 chapters, and is profusely illustrated.

XUM

A Discussion on Cupola Practice.

A meeting of the London Branch of the Institute of British Foundrymen was held on Saturday, November 24. Mr. V. C. Faulkner, the Branch-President, occupied the chair.

Following Mr. A. A. Liardet's Paper on "The Foundry Cupola and Mechanical Charging," which has been printed in the last two issues of THE FOUNDRY TRADES' JOURNAL, an interesting discussion took place, of which the following is an abstract:—

The BRANCH-PRESIDENT (Mr. V. C. Faulkner), in introducing the lecturer, said that Mr. Liardet was President of the West Riding of Yorkshire Branch of the Institute. He had been connected with Messrs. Thwaites Bros., the steel founders, and had also studied very intensely the manufacture of modern cupolas. He had, however, recently been appointed general manager of Leyland Motors, Limited.

Small Tilting Cupolas.

MR. G. HALL said he had had a tilting cupola installed some time ago, but the furnaceman had asked why it should be tipped over, and he (Mr. Hall) had replied that the main reason was for patching-up purposes. In answer to a further question as to whether he could crawl inside, Mr. Hall had told the man he could do so, but the object of the manufacturer was to avoid the necessity for doing that. The fact was, said Mr. Hall, that the man had never tipped it since it was installed. At the same time, he considered it was useful to be able to tip them if one so desired. He, personally, would not care to have to get inside any of these small furnaces. Dealing with the question of damage to the lining of the cupola through mechanical charging, he said that some years ago he had had a cupola, and his men were determined that they would knock it about when charging, and he had put some cast-iron bricks in, which had saved it. The cupola was charged by hand, but those bricks would answer in the same way if a mechanical charger were used.

Mechanical Charging and Repairs.

MR. J. W. GARDOM, speaking of mechanical charging, said he had had bad castings through bad melting, and this bad melting was brought about because the air supply was affected. This was undoubtedly due to the arrangement of the charges inside the furnace. It was all very well to say that we could go round and change the blast and the volume, and so on, but actually, during blast, nobody seemed to have time to attend to it, so that the arrangement of the charges was important. It seemed to him that, by hand charging, more uniformity of the layers inside the furnace could be obtained than by any mechanical method. It had been said that it was difficult for a man to put the charges on to the cupola because of the bad conditions, but he believed he was right in saying that, in the majority of foundries in England, 75 per cent. of the charging was done before the blast was on, so that that argument did not apply. Again, it should be remembered that the first charge had a long way to go, and, if it were thrown carelessly into the cupola, there would be much damage done to the walls. With hand-charging methods, it was quite ordinary for a cupola to run for a year without needing repair round the charging door, but the stage which had been put up specially for repairs on one of the cupolas Mr. Liardet had illustrated seemed to suggest that repairs were extra heavy. Was there any great advantage to the usual run of English founders, from the point of view of cost, in using mechanical as against hand charging? He knew that mechanical chargers could be put out of order very easily. Usually the men were in a hurry, and the apparatus underwent much knocking about, so that the cost of upkeep was high, which was a point to be considered. It might, perhaps, save one man's labour, but did it also save his wages through the use of mechanical chargers? Apart from that, he was very interested in mechanical charging, and hoped it would be successful.

MR. M. BENBOW was also very interested in mechanical charging methods, seeing that he was shortly having an apparatus installed at his own works. He was principally concerned as to whether the mechanical charging would knock the linings away when the charges were put into the furnace. He understood that there was a sill arrangement, which shot the iron or coke, or other material, into the furnace, but was that adequate to ensure the discharge of the iron or coke down through the centre of the cupola, or did it discharge on to the wall on the opposite side?

MR. H. J. MAYBREY considered that the sudden introduction of a very large mass of metal into the furnace by means of a mechanical charger was bound to have a very detrimental effect on the life of the furnace. That was a very important point to be considered.

A Method of Breaking the Fall.

MR. R. SHAW referred to a mechanical charger which he had seen twenty years ago. It was of the ordinary bucket type, and those using it had rigged up some long, heavy weights just inside the charging hole. These were hung on chains, and the charge discharged right against them. Evidently those people had found that the lining had suffered, and the principal use of the weights was to direct the charges so that they dropped into the centre of the cupola. He had not used a mechanical apparatus personally, and was rather sceptical about its spreading the charge properly. In his own practice he took the greatest care to spread the charges evenly up to the charging door, and after that it was fairly easy to keep the charges level. Every charge was put on as carefully as possible, and he could not visualise a mechanical charger doing it so well.

Labour Saving Aspect.

MR. G. C. PIERCE said that he was open to conversion, but was very sceptical as to whether a mechanical charging apparatus was beneficial when considered from all points of view. In the course of the lecture he had noted that two men were required for a mechanically-charged furnace with a capacity of 4 tons per hour. He had seen more than one furnace with a greater capacity than that worked by two men, and he had been trying to balance up in his mind whether it was really economical. Could Mr. Liardet give any figures, because he himself could not see that there was a great saving effected? After all, first cost had to be taken into consideration, as well as upkeep, so that it appeared that there was not much in it. If there were a saving, that had to be set off against damage to walls, etc.

Swedish Methods.

MR. H. G. SOMMERFIELD (Branch Hon. Secretary) said that the cupola was the most used and, in all probability, the most abused appliance in the foundry. At one particular foundry which he knew of in Sweden, which had works covering a very large acreage, he had spoken to the works manager last year about a system of mechanical transport and mechanical charging of cupolas. They had to push their iron and fuel along in big trolleys, and man-handle every pound of it to the charging stage, and at this time of the year both the iron and the fuel were under snow. The works manager had told him that the cost of the installation and the extra cost of machines, and so on, was not warranted, and thought that, with the fairly low cost of labour, the transport and hand-charging of cupolas was quite sufficient, and more satisfactory from their point of view. The supervision there could then be greater than with mechanical charging.

The Construction of Tuyeres.

MR. WESLEY LAMBERT asked whether there was not a greater tendency towards scaffolding in the cupola when mechanical charging methods were used than with hand-charging. Also, would Mr. Liardet kindly explain the object of the construction in the bell-mouthed orifice in the tuyeres?

In theory, he believed, the introduction of such a constriction was bad, and he had always understood that it should be avoided. He would like to know whether Mr. Liardet had found any advantage in having a constriction in the throat of the bell-mouth tuyere as shown in Fig. 7.

Question of Rows of Tuyeres.

MR. E. H. BROWN, referring to the actual construction of the ordinary cupola, asked Mr. Liardet what he considered were the advantages to be obtained by the use of the double row of tuyeres. He personally had found them anything but satisfactory. In nine cases out of ten, where cupolas had two rows of tuyeres, the top row had been shut off, and only the second row was working, and he had found that the double row led to a tendency towards greater variation in the quality of the finished metal, and was not to be relied upon to the same extent as when the melting was carried out in a definitely narrow melting-zone, which was far easier to obtain—theoretically, at any rate—with a single row of tuyeres than with a double row. Then Mr. Liardet considered that the Roots blower, *i.e.*, with the positive, or very nearly positive, drive, was very much superior to the fan. He himself had seen the two systems working side by side on several occasions, and in almost every case the fan was working with a lower consumption of power for the same delivery, and, in his opinion, the fan gave a better chance of varying the pressure according to the varying resistance in the cupola itself. Towards the end of a blow it was quite a simple matter, with a fan, to shut down the speed, and so reduce the actual volume of air going through when the pressure was lower; also, with a fan, the pulsation was considerably less. The tendency was to give a far more regular blast, and for that reason, if for no other, the fan helped to ensure regular conditions inside the cupola. When producing a standard metal of definite composition, it was undoubtedly a very great advantage. With regard to charging direct from trucks into the cupola, that was an advantage in a foundry where a definite composition was not of very great importance, but where a very high-quality casting was being produced, there must be facilities for obtaining the analysis of the metal before actually charging. With the present variations between the makers' stated composition and what was actually obtained, that was rather an important factor. With regard to the bell-mouthed tuyeres, he appreciated that they were very good in theory, but tuyeres were articles that wanted renewing somewhat frequently, and what was the extra cost of making them bell-mouthed as against the plain type?

Sampling Flue Gases.

MR. MCRAE SMITH said that, like Mr. Benbow, he also expected to be interested in mechanical charging in the future, particularly in the inclined plane type of charger with the skep. He had hoped to hear something from those who had had experience of mechanical charging, but he was afraid there were many pessimists present; he had hoped to hear some optimists. With regard to the sill plate arrangement, could Mr. Liardet give his assurance that it would ensure equal distribution of the charges, and had the irregularities in the size of the iron anything to do with the equal or unequal distribution? Figures had been quoted with regard to the analysis of flue gases from the cupola, and he would like to know whether Mr. Liardet had any experience of sampling the gases from near or beneath the charging door. If so, he would like to know his method. As to air pressure, had Mr. Liardet any experience of systems of measuring the volume of air going into the cupola, because the ordinary water gauge on the cupola gave very little information about it?

MR. J. W. GARDOM said that the best type of mechanical charger he had ever seen was one in which the truck, which had a drop bottom, ran straight into the cupola. That had not been mentioned.

Age of Types of Cupolas Compared.

The BRANCH-PRESIDENT said there was one important question which everybody had neglected. Mr. Liardet had given a comparison of four cupolas. He (the Branch-President) would like Mr. Liardet's assurance that these were modern cupolas and were being put on to the market at the present time, because it was not fair to compare a 1923 model of one particular maker with an older one. As to the calculations with regard to the theoretical amount of coke and the blast needed to burn the coke, apparently Mr. Liardet had not taken into consideration the expansion due to temperature factor which must exist, and which, he imagined, would alter materially the calculations.

THE LECTURER'S REPLY.

MR. LIARDET referred first to small tilting cupolas which Mr. Hall had never seen tilted down. As a matter of fact, he (Mr. Liardet) never could understand why cupolas were designed like that. The air came through the trunnions, and the trunnions had two ports in them, a sort of circular valve arrangement, so that, when the cupola was pulled down, the air was shut off. He could not imagine a person pulling down the cupola in the middle of a blow and shutting off the air. As to cast-iron bricks, he would not admit any necessity for cast-iron bricks with a mechanical charging device, even in the top section of the cupola. They certainly added to the life of the brickwork, however, under any ordinary conditions. He pointed out, in this connection, that the British Admiralty would not instal a cupola at any dockyard unless, for a distance of 8 ft. below the charging door, there were hollow cast-iron bricks, through which air was circulated to keep them cool.

Defence of the Mechanical Charging.

As to Mr. Gardom's remark that bad castings were produced through bad melting, that was quite correct, and he agreed also that it was important that the charges in the cupola should be regular. But there was no reason why we should not do equally as well as by hand charging if the iron were sent up in a bucket and tipped in. There was no difficulty at all in getting the right mixtures. It must be remembered that, after all, the object of running a cupola was not to get even and consistent charges, but even and consistent results from the cupola. No one would go inside the cupola to see how the pigs were lying, provided that the metal that came out was as it was required, and what had to be avoided with mechanical charging, or with any other system of charging, was the overlapping of charges. If there was overlapping, there would be trouble, because one part of the coke would burn before another, and the iron would mix up with the coke. If the layers were moderately level, there would be no trouble. Mr. Gardom had also said that charging machines were not applicable in this country because 75 per cent. of the charging was done before the blast was on. The only answer he could give to that was that he had had some three years' experience of charging machines in this country, and could assure Mr. Gardom that 75 per cent. of the charging machines he had fitted had been fitted to cupolas of that description. The skep hoist charging machine appealed to the small man. If a man was going to put down a cupola to turn out 4 tons an hour, there was a great incentive for him to have a mechanical charger with it, because he would get the plant more cheaply to start with, and would get better results. Therefore, he did not think the fact that small cupolas were used was an argument against the use of mechanical chargers. With regard to repairs to the cupola linings, he assured Mr. Gardom that the mechanical chargers did not damage them. Why should more damage be done by tipping the pigs from a truck than by charging them by hand? The pigs could only strike the lining once. He confessed that there was a greater tendency to crush the coke, but even that was not detrimental. He had investigated that very carefully, and had not found any loss in the coke, although it was broken because of the heavier load coming down. As to the use of a truck with a drop bottom, he had seen such trucks in operation in the United States, and the only thing against them was that he believed the trucks themselves got pretty well damaged, because they had

to go right into the heat in the cupola. But they were quite satisfactory from the charging point of view, because there was a clear vertical drop of the charge into the cupola, which we were trying to aim at. The coke was crushed more than it would be otherwise, because the pigs were dropped from a greater height.

How the Fall of the Charge is Broken.

The object of the sill which had been mentioned by Mr. Benbow was not only to bring the charge to the centre of the cupola, but also to decelerate its fall. The decline was fairly flat, so that the iron did not run down quickly, but simply fell over the edge. Besides reducing velocity, it reduced damage to the coke. He had always been more worried about the coke than the lining.

With reference to the charging apparatus which Mr. Shaw had seen twenty years ago, he himself knew of a mechanical charging apparatus which had been in use for a very long time indeed at Horwich, Lancashire, and which seemed to be quite satisfactory. There were trucks, which were wheeled along on the platform level, and the charges were put into a cradle and sent up to the cupola, but the action of tipping was just the same as in other cases.

Labour Saving Possibilities.

Replying to Mr. Pierce, with regard to economy in labour, MR. LIARDET said that the reason there were two men employed on the cupola melting 4 tons per hour, which he had illustrated, was that there happened to be a wall between the cupola and the foundry itself, and possibly, if a hole were made through the wall, one man would be sufficient. He had seen cupolas of that size operated by one man only. However, he did not think that anybody who came to a foundry to talk about mechanical charging would say first of all that he was going to effect a saving of labour in respect of cupolas of 4 tons per hour capacity. He did not think that mechanical charging in that case would save a man, but it would provide perfect control over the charges. How often did the foreman go on to the platform? With mechanical charging he would be able to see what was put into the buckets, and the different mixtures could be checked and weighed. But he (Mr. Liardet) had fitted chargers of the type used on the cupola Mr. Pierce had referred to, to cupolas of 12 tons capacity, and there was not the slightest doubt that saving was effected there. As to upkeep, the machine was very robust, and he did not see why it should be subject to any more wear than an ordinary hoist.

Scaffolding not due to Mechanical Charging.

As to the tendency towards scaffolding, he did not see why there should be a greater tendency in that direction with mechanical charging than with hand charging. He had found one cupola, fitted with a charging machine, in which scaffolding had taken place, but, on investigation, it was found to be purely a question of the handling of the cupola. There was insufficient flux used, and the blast was not quite right. The bell-mouthed tuyeres, to which Mr. Lambert had referred, were made the same shape as a pipe which passed the greatest quantity of air for any given pressure in the air-blower; not only did a pipe of that shape pass the greatest volume of air, but it also gave distribution inside. There was not a constriction. What Mr. Lambert had referred to as a constriction was the recognised diameter; in the ordinary way, tuyeres of that diameter would be adopted, but, by bell-mouthing on the air-belt side, more air went through it than would go through a straight pipe. With a straight pipe, the coefficient of discharge was in the neighbourhood of 0.5, but with the bell-mouthed pipe he believed the coefficient was as high as 0.9.

The Disposition of Tuyeres

With regard to the double row of tuyeres, he would not discuss that point with Mr. Brown, because possibly they were both right. He had tried cupolas with one, two and three rows, and he believed that, with two rows of tuyeres, there was better melting; also, if there were two rows, and one row had valves, it could be shut off. Probably, as Mr. Brown had said, they were shut off after the first week and never opened again, but he was of opinion that, taking everything into consideration, a double row gave better distribution of blast inside, and the tuyeres need not be too large. It was not the right thing to have a big tuyere area in one row, because there would either have to be a large number or the diameter of the tuyeres would have to be large. As to the Roots blower *versus* the fan, he did not think it was quite right to say that the fan was better because the quantity of air could be varied. What could be done with the fan in that respect could be done with the blower, by lowering the speed or by allowing the air to escape into the atmosphere. He did not dispute that there were many cupola plants running perfectly satisfactorily with fans in this country, but he could only say that, if we wanted the very best controlled melting, he was sure we could get it by means of the positive blower rather than by the fan. As to facilities for obtaining an analysis of the metal before charging, Mr. Liardet said that, with mechanical charging, the pig-iron could be graded in the yard; the pig-iron required could be selected and weighed out, and sent up in the right order. He did not think the bell-mouthed tuyeres cost much more than the straight ones, because they were only castings, and could be produced easily once the pattern was made. In attaching these tuyeres to the furnace, a space was left, the tuyeres were dropped in, and packed round with ganister to keep them in position. As to the size of the iron, half-pigs were quite satisfactory for cupolas of over 4 tons, and probably quarter-pigs for others. As to the analysis of flue gases, that was quite a phantasy on his part. The volume of air could be measured by finding the velocity passing through any given area in a certain time, and therefore all so-called volume-measuring gauges, which were very beautiful, but expensive, really did no more than measure pressure, which indicates velocity.

He was glad that the Branch-President had pointed out that it was perhaps unfair to have compared four cupolas without knowledge of the date they were constructed. Those four cupolas were not guaranteed to be modern, and he had no information as to the date of their construction. But they were all constructed by firms whose names are in the market to-day for the sale of cupolas. As regards expansion and temperature, he did not think that came into a theoretical discussion of the amount of air required, because, after all, what was wanted was oxygen, and not the weight of air. The volume which he worked on was taken at ordinary atmospheric temperature and pressure.

Vote of Thanks.

MR. WESLEY LAMBERT, in proposing a hearty vote of thanks to Mr. Liardet, said he had thoroughly enjoyed the Paper. There was not very much agreement among those present with regard to mechanical charging, but that did not detract from the value of the Paper, because Mr. Liardet had brought to their notice the different types of apparatus in use.

MR. C. A. OTTO, who seconded, said that Mr. Liardet could be congratulated on the discussion he had aroused; it did show that considerable interest had been taken in the Paper. Incidentally, there was one subject which had been mentioned at the first meeting of the session, and which he had thought might have been mentioned in this discussion. Mr. Liardet had referred to a cupola in which it was possible to get six or seven different kinds of mixtures. At the previous meeting referred to, two members of the Branch had discussed that subject, and there was some difficulty in coming to any sort of decision as to whether it was possible to get more than one definite mixture from the cupola.

MR. LIARDET, in returning thanks, said if the mechanical engineer had given more consideration to the foundry in the past, he did not think there would have been quite so many dissentients at that meeting with regard to mechanical charging.

Improvements in Foundry Practice.

In the course of an address delivered before the National Founders' Association in New York recently, MR. ENRIQUE TOUCEDA (consulting metallurgist to the American Malleable Castings Association) noted one or two interesting improvements that have been introduced into ironfoundry organisation and practice. Dealing with the matter of floor space in the charging room, as to which complaints had been rather frequent, he remarked that the most efficient steps for dealing with this matter had been taken in the large foundries in New England, where, in one of the best he had seen, the charging room is comfortable and clean, very well ventilated, and so large that a month's supply of coke could be, and was, stored at one end.

It was interesting to note how the coke proposition at this plant was handled. A railway siding ran parallel with the rear wall of the charging room. A pit of appropriate dimensions had been built under the tracks, and from the bottom of this pit to a hopper on the roof of the charging room ran a skip hoist. As the coke arrived in the yard, a railway wagon was placed over the pit and the coke discharging from the wagon bottom was allowed to drop in the skip. The skip was raised and the coke dumped automatically into a hopper, from the bottom of which were tubes that ran through the roof into the charging room. On trolley rails, running from the coke pile in the charging room to the cupolas, hung a coke bucket, the bail of which was connected with a trolley carriage that rested on that part of the trolley rails to which an overhead suspended scale was connected during the loading of the bucket. The operator forked the coke into the bucket until the proper weight was obtained, pushed the bucket over to the charging door, released the trip and dumped the coke into the cupola.

Twin Cupolas.

At the same foundry twin cupolas were used. They were 4½ ft. apart and built integral; between them was a rectangular hearth, its bottom being level with that of the cupolas. This assemblage was called a "melting unit," of which there are two. Both cupolas in the unit were run at the same time, and under the conditions stated the molten metal was obviously at the same level in the entire system. Through this design a very clean and hot iron was obtained, lower in sulphur than obtainable if the hourly capacity of metal was melted in one cupola.

The cupolas had two charging doors opposite each other, one for the coke and the other for the pig-iron. The pig-iron was not raised to the charging room floor by an elevator, but was placed in a side-dumping car attached to a cable and was discharged directly into the cupola upon its arrival opposite the charging door, the door sill being protected by an inclined wearing and guiding plate. There were numerous advantages in the use of the incline over the elevator. The mixtures for the day were put up under cover and in the vicinity of where the incline started. In this manner the pig-iron and scrap could be placed on the charging cars and run up to the charging floor with less labour and more convenience than was possible where an elevator was used and where the mixture was spread all over the charging room floor.

Rough-Cleaning Large Castings.

Describing an arrangement at another foundry for rough-cleaning large castings as they came from the foundry floors, the author said that for this purpose a space about 20 × 20 ft. was inclosed by a galvanised-covered wooden fence about 8 ft. high. On one of the sides were doors of such size as to permit the introduction of the casting that was to be cleaned. Protruding through appropriate openings on one side were two hose nozzles about 3 ft. apart, mounted on flexible connections that admitted of their being pointed in any direction. Above the nozzles were small windows that enabled the operator to see what he was doing from his position outside of the enclosure. Both on the inside and outside of the flexible joint a piece of loose canvas was tied round the nozzle and the edges tacked to the fence, so that water could not spray on the operator. A stream of water at about 200 lbs. pressure was played on the castings, which were cleaned at a very low labour cost and with a prevention of the dust nuisance that invariably was an accompaniment of all other methods.

Cupola Blast Pressure and Tuyeres.

In some remarks on cupola practice, Mr. Touceda said that any blast pressure in excess of that required to penetrate to the centre of the coke bed was detrimental; it did not facilitate combustion, and could actually interfere with the attainment of the highest temperature desired, while it was hard on the linings. What was desired was only that amount of air in lbs. that would burn the number of lbs. of carbon in the coke used. Theoretically, one lb. of carbon required that amount of oxygen that was contained in 11.5 lbs. of air, which would be equivalent to about 152 cub. ft. of air at 70 deg. Fah. As coke contained ash and consequently did not consist wholly of carbon, a safe average for coke would be about 137 cub. ft. per lb. of coke.

Parallel lining of cupolas gave best results. If a taper was used, it should be one with no abrupt change from the larger to the smaller diameter, otherwise irregularity in the settling of the charge and the rearrangement occasioned meant loss of heat and non-uniformity in composition; or the following serious condition might result:—All were familiar with what was called foaming slag. This condition was usually attributed to the use of light or bad coke, but this had not been his (the speaker's) experience. He had always traced this trouble either to an abrupt change in stack to hearth diameter, to failure to keep the region around the melting zone in proper repair, or to the charging of the stock in such a manner that one side of the charge was higher than the other, and consequently settled unevenly. No cupola was correctly charged in which anything but coke could at any time come directly in front of or too near the tuyeres, and this could very easily obtain if the foregoing principles were violated. If the charging was such that iron instead of coke came in front of the tuyeres, then the air blast would oxidise the iron with extreme rapidity, which, being a base, would immediately attack the acid lining of the cupola to form a slag consisting of silicate of iron. This being formed directly in front of the tuyeres, would get filled with air like a sponge, would clog the tuyeres, and possibly foam out through the charging door if the case was a bad one.

French Iron and Steel Output in November.

On December 1 there were 119 furnaces in blast in France (compared with 116 on November 1), 57 were ready to be blown in, and 43 under repairs or reconstruction. The output of pig-iron in November totalled 536,149 tons (including Lorraine's share of 194,609 tons), as compared with 514,230 tons in October. The November output included 30,812 tons of forge iron, 99,111 tons of foundry iron, 2,407 tons of Bessemer iron, 378,839 tons of basic iron, and 24,980 tons of special pig-iron.

The French steel output in November totalled 492,527 tons (including 159,535 tons from Lorraine), as compared with 476,696 tons in October. The November output included 6,456 tons of acid Bessemer steel, 307,080 tons of basic Bessemer, 172,744 tons of open-hearth steel, 1,271 tons of crucible steel, and 4,976 tons of steel made in electric furnaces. Ingots totalled 479,931 tons, and castings 12,596 tons. The November total is the highest monthly output reached in 1923.

Indian Pig-iron Imports, 1923.

Indian pig-iron imports during the first ten months of 1923 totalled 4,446 tons (including 3,824 tons from Great Britain), as compared with 19,400 tons during the corresponding ten months in 1922.

Canadian Pig-iron and Steel Output in November.

The production of pig-iron in Canada last November was 62,202 gross tons, a decrease of 11,396 tons on the October output. The cumulative production of all grades of iron for the eleven months ending November was 820,396 tons, an increase of 114 per cent. over the same period last year. The output of steel ingots and castings in November was 54,674 gross tons, a decrease of 12,822 tons compared with October.

XUM

Institute of British Foundrymen.

COVENTRY BRANCH.

Discussion on Mr. Cole Estep's Paper on "Quantity Production in American Foundries."*

MR. G. E. ROBERTS, opening the discussion, thought it would be the general opinion that the Paper had been interesting and informative. He was very much struck by one statement which he believed was made as to the handling by three men of 46 tons of sand per day of nine hours. That seemed to him rather more than they could get in a British foundry. He understood the sand was shovelled into a riddle and then conveyed by an elevator to a hopper.

It was his view that, if employers realised better the ideals which were put before them at such lectures as these, they would see the benefit which would be likely to accrue to their staff if they attended them, and therefore he suggested that they might well do something more to encourage their employees to come to these meetings.

The Maintenance of Quality.

MR. PLAYER, who took the chair in the absence through illness of the President (Mr. C. Dicken), commenting upon the saving of floor space and flask equipment, said Mr. Estep had given them some interesting figures as to the casting output per day per unit of floor area; and although he did not mention it, he (the speaker) assumed that all this was green-sand work, because he did not see how it could possibly be otherwise. Dry-sand work for cylinders involved considerably more flasking for such a quantity of castings. So far as he was aware, cylinder casting for the automobile trade was nowhere largely carried on in this country in green sand. Why this should be so he did not quite know, except that from his experience he had found it a somewhat difficult proposition, from a foundry point of view, owing to the manner in which British cylinders were designed. It was a very important point, affecting costs as it did, and he should be interested to know Mr. Estep's view of the matter, as no doubt would many others present who had encountered the same problem. He fully endorsed the statement that in any foundry organised for anything approaching quantity production, the chief concern of the management was inevitably the maintenance or improvement of the quality of the output. Certainly, in his firm's limited experience of quantity production, he had found that quantity more or less looked after itself, provided the system was well launched, and that the equipment, the men and the lay out were sound. But quality never looked after itself. It was said that the price of safety was eternal vigilance, and nowhere did it more aptly apply than in the foundry. They did one thing to-day, and thought a defect had been removed, and that no further trouble would occur. Nor would it if they kept a strict watch day by day and hour by hour; but if they did not, then the trouble would arise again. Regarding the covering of runners by white paper, it was a good idea; for while it probably did not make any difference to the casting, it acted as a continual warning to everybody to be on the alert. At his firm's works they went a little farther, using thoroughly well-tinned sheet iron, which was placed over the runners immediately the mould was closed. The lecturer mentioned that for the production of one type of cylinder block some 259 jigs for core assemblies which were interchangeable were made and used, and cost not much more than £10 per set. The devices he quoted, however, would involve a outlay of capital almost sufficient to start a British foundry in good style. Still, it did show to those of them who were directly or indirectly interested or worried in making motor cylinder castings how important the checking of cores was, because although the pattern-maker referred with pride to his core-boxes and blue prints, they did not always seem to turn out so satisfactorily in practice. There were many people, who made castings for any customer who happened to have the money and the will to buy, who were not making them for their own finished product, and if they were to embark on the lines mentioned in the lecture then he was afraid they would soon find themselves faced by the Official Receiver in Bankruptcy. The difficulty was that there was some bacillus in the English designer which made it impossible for him to retain any particular dimensions for more than three weeks on end. It was, unfortunately, only too often the case that they were informed by a customer that he must have 10,000 immediately, and when they had made tons of moulding boxes and pounds' worth of jigs and tackle, and had started production, the order came to stop the job. The pattern-maker and draughtsmen were sent for, and the result was that they found the four-cylinder 11.9 job had been changed to a six-cylinder one, on the same pattern, of course. That was perhaps a little exaggerated, although he was not wholly joking, because he had experience of cylinders which had been "educated and grown and become rejuvenated" not on one pattern, but several. The jig problem was even more acute in this country than in the United States, as he believed they were saner over there, or else had a wholesome fear of the foundryman.

Why Green-Sand Cylinders Fail.

He thought he could put his finger on one spot as to why they in Britain did not seem to succeed in producing cylinder work in large quantities by green-sand moulding, which, of course, had a considerable influence on output. It was design. The designs which they had submitted to them were not made with a view to simplifying the moulding, with the result that they could not cut out the gaggers.

Chemical Composition and Quality.

Coming to the interesting subject of the composition of cast iron, MR. PLAYER said they had been slaves too long to an analysis of the simple elements; and while foundrymen appreciated the point that they could have iron with identical analyses which was quite different in those characteristics which undoubtedly arose from the balance of the elements in the form of internal constituents, they would all be glad of some real enlightenment on the problem. If they could ascertain why one concern, with a sample of cast iron of the same analysis as a second, should obtain a product which came out much denser in structure and be different in its tensile and transverse strengths compared with the results of the second company's tests, then much progress would be made.

Frequent Change of Design Hinders Quantity Production.

MR. A. HARLEY said they might describe the lecture as a statement proving that quality was not inconsistent with quantity production. It also appeared to give some sort of hint that they on this side of the Atlantic had been inclined to regard quantity production as meaning rather lower quality. He did not know whether this idea had been encouraged to some extent by a Paper delivered before the American foundrymen by Mr. Cook, in which an attack on the quality of certain American productions was made. But he thought he was justified in saying that his attitude had not been generally accepted in this country. He did not think there was any widespread idea in this country that American quantity production meant poor quality. Indeed, so far as Mr. Estep's Paper was concerned, he considered that he had proved as a matter of common sense that quantity production made for quality; because it was only when they could obtain a large output that all these refinements of control and checks could be introduced, seeing that under such conditions they could better afford refinements. As the lecturer pointed out, there was a large volume of work going through the foundry daily for which it was essential that the most careful checking and safeguarding should be

* This Paper, which appeared in our issues of December 14 and 28 of 1922, was originally read before the West Riding of Yorkshire Branch.

taken, otherwise it was easy to lose thousands of pounds in a day in the event of a serious breakdown. In small foundries perhaps they could not afford all these checks, because they were worth trying, and if something did go wrong there were not the same disastrous consequences. Personally, he was not inclined to lie down under all that had been said, supposing there was any inference intended that they in this country were wrong in not adopting the lines of production which had been described. He must, however, make this qualification; he did not think they had really mastered the problem of the quantity production of cylinders, for instance. But the reason for this was very simple. It was because they did not get such large quantities to make with any guarantee of no alteration to justify quantity methods. Still, in their limited way they had applied many of the methods described in regard to checks and control of quality. While in his foundry they did not use paper covers for runners, nor sheet tin, for many years—in fact, ever since the Daimler foundry was started and turned out cylinders—they had used stout cardboard for the purpose mentioned. As to the position of the foundry manager, he agreed that the pattern shop should be under his supervision, and he would go further and say that the laboratory should be also. He was assuming, of course, that the foundry manager had sufficient knowledge of metallurgy and chemistry to apply the information supplied to him.

Rapid Analysis of Iron during Manufacture.

He was rather impressed with the analysis of iron at the cupola. He understood that every ladle was analysed for the usual elements. It was desirable to have more information about this, and as to the methods by which it was carried out, because it meant that if a full analysis was taken in time to give a check within a few minutes, in case there was anything wrong with the metal, it could be corrected and much waste prevented. But while many of the elements could be tested pretty rapidly, he did not know of a method by which combined carbon could be done in a few minutes. However, it appeared to him that there must be something not quite in order with the cupola practice to require this analysis. In other words, the laboratory did not on the face of it appear to have much confidence in the melting operations. His own experience was that proper laboratory control for the material going into the cupola was a necessary and primary essential. Every truck of iron entering their foundry was analysed, and received an index number; and with a proper knowledge of the coke and limestone used, together with the blast, cupola practice should be carried on from day to day with very little variation in the metal produced. At the Daimler foundry they had a certain amount of testing of the iron as it came out of the cupola, but they were content to know the percentage of silicon on account of the greater variation in this element in pig-iron, though fortunately this was within limits. This was not so much the case with some of the other elements. For instance, manganese in any particular brand of iron was fairly stable; so was phosphorus and sulphur, as a rule.

High British Tensile Tests.

In reference to tensile strength, he did not think they had a great deal to learn in this country. The lecturer had given figures of 16 to 17 tons tensile strength in various classes of work. In their own foundry, on a special class of casting during the war, tensile tests of every batch were taken each day, and the tests of these cast-iron castings never dropped below 18 tons, and frequently the figure reached was over 19 tons. He thought this was a record which was worth mentioning, as showing that they could if they liked turn out very high tensile iron and maintain that standard.

Buying Pig-iron to Analysis.

It had been their practice for years past to buy pig-iron to analysis, and if a purchase did not satisfy the required specification, it was returned. Then in connection with the system of checking cores and moulds, this had been a regular practice at their works, as well as in other foundries with which he was acquainted. When made, their cores were passed into the core stores and inspected with gauges; unless they were satisfactory under test, they were not allowed to pass out for use. This stores had a stock of every core made, and was responsible for their issue, so that they knew exactly where they stood in regard to these cores. Proceeding, Mr. Harley said the lecturer had mentioned the frequent checking of the temperature of molten cast iron by means of an optical pyrometer. He would like to know whether this method had proved to be reliable, and if so what was the make of instrument used. He was also interested in the green-sand moulding of cylinders. Now if they in this country could find it possible to do that, as it was done in America, the foundry trade would be able to make rapid strides in production which would react on the motor and similar industries to their great advantage. At present they dried their cylinder moulds. Much attention had been given by his works to the compounds in iron. They did not consider the chemical analysis as sufficient by itself. If they were doubtful about any iron, they preferred to know its structural analysis, which was a matter which could be calculated with more or less certainty from the chemical composition, allied, of course, with observation through the microscope. Generally speaking, he thought that even in comparatively small foundries much more should be done in this country on the lines indicated in the Paper. Checking and control paid for itself. He had often heard it said by foundry people that they could not afford a laboratory as they were only a small foundry. But such foundrymen might effectively direct their attention to the percentage of scrap in their foundries during the year. In most foundries this was an important item, even in the best managed of them, while in some others the amount of scrap must be enormous. But under the control of an efficiently directed laboratory and a sound mechanical system, a large reduction of scrap was easily obtained. And he might remind them that it did not take a very large reduction in the percentage of the scrap bill to more than pay for the necessary outlay involved.

MR. F. HILL asked why, if quantity production had been such an immense success in the United States American firms having branches in this country did not adopt similar methods here, but instead conformed to English methods of working. He knew a foundry near Coventry where motor cylinders were cast in green sand.

Health Conditions in American Foundries.

MR. WHITWORTH remarked that the success of quantity production in America was largely due to the fact that it was a continent. Consequently when something was found which appealed to the public taste they were able to sell in forty markets against perhaps a couple by this country. Then the important resources which America possessed in raw material gave her a great advantage, and the size of the country afforded a stable market which Great Britain did not get. He would like to know what relation had the health of the foundry worker in the States to the health of workers in other industries, and also their general length of life. Did the lecturer think that as a result of this very fine specialisation there was a tendency to eliminate the craftsman's pride in his work, and that it went against the feeling that one liked to do the best work possible. Further, were foundry workers in America of the regular or casual type as a general characteristic?

MR. SHAW observed that one reason why so much control was required in the States was that so many languages were spoken in the foundries owing to the mixed nationalities out there. But many of the heads of these organisations were British. Mass-production methods were not born in America, for Adam Smith, the great economist, showed in his historic work that it had its beginnings here, although they did not carry the matter to its logical conclusion. He had discovered in America that in some cases the foundry manager was also the foreman pattern-maker, who happened to be the most technical man in the foundry. He must admit that the American foundries did make mechanics of their men. As one who had acted in an executive capacity in the States, he could assert that the pattern-shop was considered

the brain of the organisation. But here in this country they had not the quantity to deal with, though he ventured to say they could accomplish quantity production quite well if necessary. It was during the last 15 years that mass production had been devoted to quality, but 25 years ago that was not so.

MR. G. H. JUDD suggested that the lecturer might hand on to the blast-furnace people the principle of producing pig-iron to specified analysis, as analysis at the foundry end was absolutely essential to-day.

THE AUTHOR'S REPLY.

MR. COLE ESTEP, replying to the discussion, emphasised that he did not present his Paper with the idea of making comparisons. He had been in England long enough to know that the conditions in the two countries were entirely different, and that they could not transfer methods without modification to suit the circumstances of the other. America had a large output because she had a large market. He believed that to run a foundry in this country at a profit required more hard thinking and more intelligent direction than in some other countries. Another reason for their big market, which was especially interesting in view of the discussion which was taking place in political circles just now, was that they in America kept their market to themselves. Further, there was that other considerable factor that in a comparatively new country large developments were taking place and the distribution of wealth was rather different, with a larger proportion of people having money to spend. During the last seven or eight years the tendency has been very strongly to recruit foundry managers from the technically-educated and university-trained engineers. It was perfectly true that a large proportion of the foundry executives were of British origin. He knew of 25 or 30 who had gone out to America, and with the sound training that they had already received it was not difficult for them to become foundry managers in the course of a short time. This, of course, supported his contention that it required brains and intelligence to run a foundry at a profit. Regarding Mr. Roberts' question, he did not say the men shovelled the sand throughout, but that they handled a machine which mixed the sand. The men shovelling in the sand worked nine hours a day, three being on the job and doing 15 tons each. Most of the cylinders, he replied to Mr. Player, were green-sand cast, and in some cases were given a light skin dry with a gas torch. The question of design entered into the use of green sand; and also in moulding cylinders in green sand they had to exercise great care as regards the proportions used, the operation being done mechanically and supervised by skilled men. As to Mr. Harley's inquiry on the analysis made from the ladle, the metal was for special work, the foundry being required to turn out valves for high pressure superheated steam. The management felt that they had to be unusually careful, because should one of the valves blow up casualties might occur. The optical pyrometer he had mentioned seemed to give fairly satisfactory results, although they were admittedly only approximate. The optical pyrometer was not yet, he thought, fully developed. He agreed with him that the laboratory should be under control of the foundry manager in so far as routine control and cupola practice were concerned, but the checking up should necessarily be in independent hands. What he had stressed was the inspection of castings and the testing of them when finished, with which the foundry should have relatively little contact. As regards the feeling in Great Britain with reference to the whole problem of quality in quantity production, he himself made no suggestions. But there might be some spots in the country, as indicated by Mr. Harley, and also some places in the United States, where there was a feeling that high speed and pressure methods did not necessarily go hand in hand with quality; but that was not general either here or there. Mr. Whitworth had inquired about the health of the American foundry workers, but he was afraid he could not give any qualified opinion, the question being one for medical investigation.

In answer to Mr. Hill's question, he had already said that it was useless trying to transfer methods to another country where they did not apply. He had not presented his Paper in a critically comparative light, but had simply given a picture of what was being done under the conditions existing in America. As to Mr. Judd's query as to putting the proposition of pig-iron analysis to the British blast furnaces, he might point out that he did not say the quality of the metal was so uniform that it was not necessary to analyse it, but that the analysis made at the furnace and furnished to the customers was, generally speaking, such as to make the customer reasonably sure of getting the same as that shown on the furnace's analysis. It might vary from car to car and heat to heat, but the analysis furnished represented the iron shipped. He might add that last year conditions arose whereby the market for pig iron in the United States, particularly in the east, was enormous, and over 250,000 tons British pig-iron were sold to American foundries on analysis. The general comment on this British pig-iron was that it was fully up to specification, and frequently better than that ordered, while there was no trouble in getting it to the required analysis.

Trade Talk.

MR. L. K. BRINDLEY has removed to 82/83, Fenchurch Street, London, E.C.3.

THE WHITE MACHINE TOOL COMPANY have removed from Warley Springs Works to Dunkirk Works, Parkinson Lane, Halifax.

J. & P. HUTCHISON, LIMITED, Glasgow, have placed an order with A. & J. Inglis, Pointhouse, for two double-deck steamers, each of 1,500 tons deadweight.

HUNTINGTON, HEBERLEIN & COMPANY, LIMITED, consulting chemical and mechanical engineers, have removed to Equitable House, 47-51, King William Street, London, E.C.4.

A LICENCE UNDER THE Non-Ferrous Metal Industry Act, 1918, has been granted by the Board of Trade to Mr. R. Yates, trading as the Jarrow Iron & Metal Company, Pitt Street, Jarrow-on-Tyne.

DOWN & COMPANY, ironfounders and engineers, announce that in future the business will be carried on under the name of F. Turnbull & Company, at the Heaton Junction, Newcastle-on-Tyne. There will be no change in the ownership or management of the business.

THE NEATH SPELTER COMPANY, LIMITED, propose to acquire the lease of the Emu Works at Skewen, and to rebuild and equip them on the most up-to-date lines. The company are offering fresh capital to the extent of 25,000 6 per cent. participating preferred shares, to rank *pari passu* with the existing shares of the company.

A NEW COMPANY has recently been registered under the title of Vickers and International Combustion Engineering, Limited, for the manufacture of power plant equipment, the negotiations which have been going on for several months between the British company and the International Combustion Engineering Corporation, of New York, having been successfully concluded. The American Corporation has made a success of the "Lopulco" patented system of pulverised coal-firing for steam boilers, some of the largest boilers ever built in America or Europe being equipped with this system. The initial capital of the new company is £500,000, which will be held by the two companies in equal proportions. The new company will manufacture at its own works at Barrow-in-Furness boilers especially adapted for the burning of coal in pulverised form, superheaters, economisers, Raymond impact pulverisers, dryers, air heaters and all other auxiliary power plant equipment, and will design, build and equip complete power plants, all units of which can be manufactured by the new company, or by companies affiliated with Vickers, Limited, or the International Combustion Engineering Corporation. The directors are: Sir A. Trevor Dawson, Bart., vice-chairman and managing director, Vickers, Limited; Mr. G. R. T. Taylor, chairman and managing director of Taylor Bros. & Company, Limited, director of the London, Midland and Scottish Railway, and managing director of new company; Mr. G. E. Learnard, president of the International Combustion Engineering Corporation; and Mr. W. R. Wood, vice-president of the International Combustion Engineering Corporation. Temporary offices have been taken at 4, Central Buildings, Westminster, S.W.1, where the business will be in the hands of Mr. G. C. Usher, who has been appointed general and sales manager.

XUM

Japan Steel Works, Limited.

The Japan Steel Works, Limited, at Muroran in Southern Hokkaido, which is next in importance to the Government Steelworks, was established in order to supplement the Government arsenals in the manufacture of war material at a time when the Anglo-Japanese Alliance made necessary some effort on the part of Japan better to fulfil her share of the obligations imposed by the pact.

The establishment of the Japan Steel Works was the result of the Government purchase in 1907 of the whole length of railway under the control of the Hokkaido Colliery & Steamship Company. This Company, wishing to invest the funds thus received, applied for Government permission to establish an ironworks. The Government was in no position to afford assistance, and the proposal was deferred. At this time Messrs. Armstrong & Company, and Vickers, Son & Maxim, Limited, were supplying the country with warships and ordnance, and these companies combined with the Hokkaido Colliery & Steamship Company in their efforts to obtain Government permission to establish an ironworks. The Government gave its consent to the starting of the enterprise upon a co-operative basis, considering that the co-operation of English and Japanese investors would realise effectually the objects of the Alliance. Thereupon the representatives of the two companies met in Tokyo on March 7, 1908, and drew up a provisional contract, which was formally concluded in London on July 30 of that year, and on November 1 the first general meeting was held.

Features of the Agreement.

Although the full details of this contract were not made public, according to information given in "The Far Eastern Review," its essential features were disclosed at the time by Mr. Kakugoro Inouye, managing director of the Hokkaido Tanko Kisen Kabushiki Kaisha, and one of the active promoters of the arrangement. According to his statement, the contract contained the following stipulations:—

(1) The Armstrong and Vickers Companies, in co-operation with the Hokkaido Colliery & Steamship Company, will establish a steel foundry in Japan with a capital of Y.10,000,000.

(2) Japanese and English companies to produce a half of the capital each, and four directors each.

(3) The Hokkaido Colliery to supply coal and the Armstrong and Vickers Companies to supply iron material and engineers.

(4) Neither party to establish a similar foundry in the Far East.

Supplementary contracts concluded in London provided:—

(1) The new concern to engage in the manufacture of ammunition, and construction of merchantmen and warships in addition to the making of steel.

(2) For the purpose Armstrong and Vickers to issue debentures to the extent of Y.10,000,000 (approximately £1,000,000).

(3) Armstrong and Vickers to abolish their sale agents in the Far East and to transfer the sale business to the steel foundry, paying to it a commission of 2.5 per cent.

(4) The Japanese Steel Foundry to give preference to the above English companies, in case the foundry is about to purchase goods by tender and prices offered are equal.

(5) Mr. Kakugoro Inouye to be president and Mr. Sukemune Kondo to be a director in addition to eight directors mentioned.

(6) Armstrong and Vickers to assign gratis their technical privileges, secrets, etc., to the steel foundry, and the Hokkaido Colliery and Steamship Company to cede to the concern the building lot at Muroran at cost price.

The foundry was established at Muroran, Hokkaido, for three reasons:—(1) The site belongs to the Hokkaido Colliery & Steamship Company; (2) it is accessible to coal mines; (3) there are ample facilities to accommodate the Company and to lease the space for the Navy and Army Departments. It was proposed to work up the ore sands that lie in such immense profusion around the large adjacent Volcano Bay. Muroran and Hakodate lie at the two points of the Bay, at the head of which is the volcano known as Komagatake.

The greater part of the plant was erected towards the end of 1910 when a domestic bond issue of Y.10,000,000 was floated that enabled the new enterprise to engage in active business in the following January, having been appointed approved Lloyd's makers and sole agents in Japan for Sir W. G. Armstrong, Whitworth & Company, Limited, Vickers, Limited, and Hulse & Company, Limited. The Works sprang at once into prominence, and aside from its specialty in munitions, took the lead in steel castings of all sizes and shapes, especially for steamship construction.

In December, 1919, the Japan Steel Works acquired through amalgamation the properties of the Hokkaido Seitetsu Kabushiki Kaisha (Hokkaido Iron Works, Limited), capitalised at Y.15,000,000 fully paid up. These works, located at Muroran, produce pig-iron and control several mines. The capital of the Japan Steel Works was then increased to Y.30,000,000 fully paid, and in 1920 a further domestic bond issue of Y.10,000,000 was floated. The Kabushiki Kwaisha Hiroshima Seisakusho (The Hiroshima Works, Limited) located at Kaida-Ichi, near Hiroshima, with a capital of Y.1,500,000 being dissolved, the property was purchased by the Japan Steel Works in November, 1920. This Company specialised in the manufacture of auxiliary machines for naval and military purposes and other miscellaneous tools largely used by the Government.

The Muroran Works.

The main Works, located at Muroran, Hokkaido, have a total area of 1 square mile, 345 acres, of which a little over 39 acres are covered with buildings. The water for the Works is drawn from the Washibetsu River about seven miles distant. The Company owns its own loading pier on Muroran Bay, being 1,300 ft. long, 60 ft. wide, and is equipped with a 100-ton wharf crane for loading and unloading heavy castings. In addition, the Works are served by 34 miles of standard- and narrow-gauge railways belonging to the Company, connecting with the pier and the Government railway system. The Works equipment, according to the latest published statement of the Company, comprises four blast furnaces (three 120-ton and one 80-ton), 12 hot-blast stoves, seven blowers, casting beds, lifts, etc., three D.C. generators of 1,000 kw. and less, 22 boilers, three coal-washing plants and 826 coke ovens. There is also a smiths' shop with steam hammers, 12 tons and less, reheating furnaces for hammering small forgings, and one rolling mill for making bars. In a pattern shop having a total area of 1,068 sq. yds. all kinds of wood-working machines of the latest design are installed. The steelmaking plant and foundry cover a total area of 4 acres. There are two 50-ton furnaces, six 25-ton, two 10-ton and two 5-ton, all of the Siemens type, the larger being served by two travelling Wellman machines. In the foundry are four 6-ton cupolas, 20 crucible furnaces for casting brass, gunmetals and other alloys, five casting pits, three annealing furnaces, and seven drying stoves capable of taking in castings of large size. Of the machines and apparatus installed, the following may be mentioned:—A wheel-centre cutting and turning lathe, circular sawing machines, band-sawing machines, sand mills, a sand blast, an electric welding apparatus, electric capstans, electric elevators, pneumatic tools, etc.

Overhead travelling electric cranes are numerous, their capacities ranging from 5 to 120 tons, besides two scrap yard cranes for transportation of foundry materials, products, and so forth.

There are 40 sets of gas producers of the latest design, supplying gas to furnaces in the foundry, forging shop and tempering and shrinking shop. Their coal consumption per day of 24 hours is 250 tons.

The annual productive capacity of pig-iron is 160,000 tons, and of steel 130,000 tons.

The forging shop has a total occupied area of 2 acres 3,760 sq. yds. The building is divided into three bays. The shop has three hydraulic

forging presses of 4,000, 2,000 and 1,000 tons, respectively, and each served by two overhead hydraulic cranes. These presses are for forging gun steels and shaftings and for turning out other forgings not exceeding 100 ft. in length and 11 ft. in breadth.

There are also in the shop one 25½-in. cogging mill and an 18-in. rolling mill, for rolling shell steels for field guns and ordinary round steel bars of 3-in. diameter or less. The mills are served by one 10-ton overhead electric crane, one shearing machine, one hot-sawing machine, four straightening machines and three heating furnaces.

An overhead travelling 60-ton crane, electrically driven, is also provided for general transportation of materials and manufactures.

Besides the above, there is a vertical 250-ton hydraulic shell punching press, another horizontal one of the same capacity, and six punching and drawing machines for field-gun shells; they are employed for punching and drawing out shells of 6-in. or smaller diameter, and other steel manufactures of small sizes.

The tempering and shrinking shop, with a total area of 3,005 sq. yds., contains an oil-tank, 80 ft. deep; a pit, 80-ft. deep; annealing, hardening and shrinking furnaces; one 80-ton hydraulic crane, etc. It is used for the heat-treatment of gun tubes, shafts and other forgings, and the building up of gun tubes.

The power station with boiler house attached has a total area occupied of 3,756 sq. yds. The plant comprises three 440-volt 1,000-kw. D.C. Lancashire Dynamo and Motor Company's generators direct coupled with Belliss & Morcom triple-expansion engines, and one 200-kw. W.D.C. generator of same design; 20 high-pressure B. & W. water-tube boilers with automatic stokers, producing 10,000 h.p. of steam. Two sets of economisers are provided for heating feed-water, and four fans to regulate ventilation. The boiler-house is complete with a coal and ash conveyer for coal charging and ash removal, automatic weighers and other necessary apparatus, and is replete with all devices for labour saving and economy in fuel consumption.

The machine shop, with total area occupied of 6 acres 613 sq. yds., is the largest building in the Works, and is divided into the two sections—rough machining and finish machining. It is equipped with more than 500 machines, including ingot trepanning machines, gun-boring machines, gun rifling machines, profiling machines, lathes, drilling, milling, slotting and surfacing and grinding machines, sawing machines, gun-wire winding machines, standard gauges and measuring machines of fine accuracy, cranes of 80 tons and less capacity, etc.

Other shops include a drawing office, laboratory, slag-brick-making shop, firebrick-making shop, and stock main store. Auxiliary buildings comprise a hospital, officers' residences, a school and kindergarten. The hospital has accommodation for 80 patients, and the general public as well as the Works' officers and workmen can get medical advice and treatment.

The 500 salaried employees and 4,000 workmen are housed in 1,200 residences, provided with complete sanitary and fire-preventive arrangements. The children of the officers and workmen are educated at the school and kindergarten attached to the Works, and a society is established for giving lessons in manual works and moral training to the families of the workmen. Special class rooms and dormitories are provided for apprentice workmen. A club house provided with all amusements, and a theatre with a seating capacity for 1,500, cater for the enjoyment of the officers and workmen, as do also a green house, a large garden, and a sanatorium erected at the Noboribetsu hot-spring, 15 miles from Muroran.

The Hiroshima Workshop.

This is situated at Kaida-Ichi, near the city of Hiroshima, and covers an area of 196 acres, of which 4 acres 1,633 sq. yds. are occupied by buildings, and over which railways are laid for facility in transportation of products, materials, etc. At the landing ground along the eastern coast a 35-ton floating crane is installed.

The Hiroshima Workshop specialises in the manufacture of shells, 6-in. or less calibre; breech-mechanisms; sighting gears; gunpowder-cans; torpedo-tubes; hydraulic pumping engines; refrigerating and cooling plants of the Hall's system; steam cylinders; ingot-cases; machines and tools; steel castings, ¼ ton or less in weight; iron castings, up to 10 tons; alloys up to 3½ tons in weight.

Ore Mines.

The total area of all mine-lots owned by the Company is approximately 136 sq. miles 206 acres, of which three mines in Hokkaido and one in Chosen (formerly called Korea) are being operated. There is also the Mejiro laboratory for ferro-titanium.

The German Pig-Iron Union.

The report was circulated last week that the Rheinische Stahlwerke (Rhenish Steelworks) had given notice to terminate the agreement binding the members of the German Pig-Iron Union, which in the ordinary course of events would not expire until the end of 1926. A later report stated that in the meantime the Union and the Company in question have come to an understanding which will ensure the continuance of the Union. For the rest the notice tendered by the Rheinische Stahlwerke would not have the same importance as would be attached to a similar notice given to the Westphalian Coal Syndicate. The Company had never appeared as a member of the Union in the open market as a seller of any considerable quantity of pig-iron, as the Company itself consumed practically the whole of its own output. When any stocks had accumulated at any time at their works they had been sold by the Union, and in times of great demand the Company was said to have placed pig-iron at the disposal of the Union for sale at the latter body's request.

Besides the Rheinische Stahlwerke various other self-contained works who also work up their own production of pig-iron are also members of the Union. It has always been considered the correct thing for the self-contained works who do not come into account as sellers of pig-iron to belong to the Union, in order that the latter should form a united association of all the blast-furnace works. Moreover, the self-contained works have always had an interest in the existence of a pig-iron combine, as unfettered competition in pig-iron would naturally also have had a prejudicial effect upon the course of prices for rolled products. Apart from the provisional notice mentioned at the outset, and since nullified by the new arrangement arrived at, no other member of the Union has sent in notice of secession. Far from this being the case, it is said that a general expression of opinion has been given, at recent meetings of the Union, of the wish to continue the combine in the future.

As to the situation of the pig-iron market, it is stated that sufficient stocks of all brands are on hand at the Ruhr plants to satisfy the requirements of the foundries in the occupied district, which are not considerable at present. Large quantities of pig-iron have been despatched by waterway, and the Régie railways have also accepted a certain tonnage for transport. A larger demand has recently arisen in unoccupied Germany, but the blast furnaces have been able to meet it. As to the question of prices it has been stated that the railway rates are so high that many works are being involved in losses. As about four tons of raw materials have to be carried to the works in order to produce one ton of pig-iron it is easily understood what influence the railway rates must have upon costs of production.

THE GLASGOW CORPORATION refused to carry out the suggestions of their Tramways Committee, as reported in our last issue. The Committee reported that they had received the following offers for special track work:—United States Steel Products Company, Limited, £8.568; Hadfields, Limited, £9.794; Edgar Allen & Company, Limited, £9.867; Titan Trackwork Company, Limited, £10.031. The committee, by a majority, recommended that the offer of the United States Steel Products Company be accepted. After a lengthy discussion it was decided to accept the lowest British offer. This decision involves the placing of the whole contract with Hadfields, Limited.

Metals in 1923.

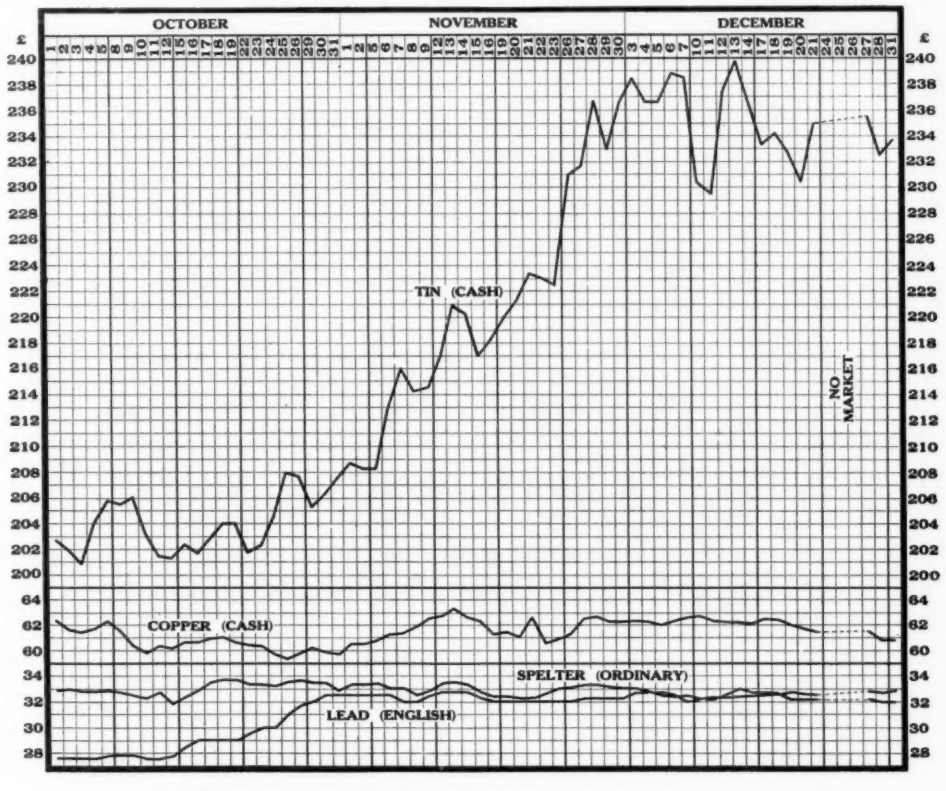
The severe fluctuations in the respective values of copper and tin constituted the most interesting feature of the metal market during the course of the past twelve months. Ruled largely by sentiment, prices periodically moved steadily upwards, but with no sound foundation in the way of improved trade, and the increased consumption that naturally would follow, the movement quickly exhausted itself and prices returned again to their former levels. Spelter and lead prices are not so susceptible to outside influences as are those of copper and tin, but values nevertheless have been quite lively in their movements during the year. The accompanying illustration shows the fluctuations in prices of metals during the past three months. Curves showing the movements in values during the first three quarters of the year were given in our issues dated April 6, July 20, and October 12, 1923 respectively.

Copper Conditions Dull.

Price movements in copper were most marked during the first half of the year. The commencement of the year found standard cash around £64 10s. From then onwards until the end of the first quarter, with the exception of occasional slight reactions, prices moved steadily upwards, the highest point—£76—being reached in March. This marked the turning point of values, a retrograde movement setting in from then onwards, until the end of the half-year saw the quotation for standard copper again in the neighbourhood of £64. As the foremost copper-producing continent of the world, America naturally governs to a considerable extent the course of the market in this country. During the first three months of 1923 the position in the United States was of a very firm description. The demand from domestic consumers was on a large scale, and although, owing to the disturbed conditions prevailing in Europe, American export trade in copper was naturally curtailed, producers were able easily to dispose of the bulk of their output, and adopted in consequence a very firm attitude. A further strengthening factor was to be found in the fact that stocks were at a low level, while the large tonnages of copper and brass scrap that had accumulated since the war had been reduced to almost negligible quantities. Meanwhile, however, consumption in the United Kingdom did not improve at the same rate, although values here were increased in relation to the upward movement of electrolytic quotations in New York, and it was recognised that when the demand in America lost its impetus the call for metal from consumers in this country would not be on a sufficiently large scale to maintain values at the levels then prevailing. This anticipation was correct. Before the half-year was ended domestic consumption in America had sunk to a low ebb, and with home consumers purchasing in small quantities in order to meet only their immediate requirements extremely inactive conditions prevailed on both sides of the Atlantic. An attempt was made in mid-year by the large producing interests to force up values on the London market, and to this end copper was actually purchased for shipment to America. This manœuvre, however, did not meet with the success that was anticipated, and values, instead of increasing, receded still further. During the second half of the year there has been nothing of an interesting nature to note. Values have fluctuated within narrow limits, and the market generally has been lethargic.

Wide Fluctuations in Tin.

The tin market is one that generally may be expected to provide sensational price fluctuations, and the past year has proved no exception to the rule. As has been shown in our weekly reports, the rapid rise during the first quarter of the year was followed by a drop that was quite as rapid during the following three months. Again, at the commencement of the second half of the year values started on the upward trend, moving steadily higher with scarcely a break, the highest point for the year being reached during the last quarter. These wide fluctuations, however, may be ascribed more to the activities of speculative interests than to the ordinary laws of supply and demand, although since the beginning of the year there has certainly been an improvement in the general position of the metal. Consumption has increased considerably; America has taken large tonnages, while better trade in the tinplate industry has resulted in an improved call for metal from South Wales. That the demand has increased was abundantly proved by the announcement that the Government of the Federated Malay States had sold 4,000 tons of tin in the open market, representing the entire percentage for eight months allowed under the Bandoeng Agreement. This announcement was made at the end of November. Later it was stated that up to December 28 the F.M.S. Government had disposed of 4,500 tons of their stocks of tin. Under the Agreement they are entitled to offer 500 tons per month. From these figures it



FLUCTUATIONS IN METAL PRICES DURING LAST QUARTER OF 1923.

appears that they have been able to dispose of the metal to the fullest extent they are allowed, it being apparent that a further 500 tons has been sold during December. It does not necessarily mean, of course, that this tonnage has all gone into consumption, as probably some percentage is held in the hands of speculators, but at the same time the fact that the large stocks of tin originally held in the East have been so considerably reduced is a strong point for the bulls. Sentiment at the close of the year was strong, and in some quarters it was confidently predicted that values would be held at present levels. However, the rise appears to have been a little too rapid to escape a reaction, although it does not appear likely that prices will sink to a level as low as that prevailing a year or so ago. A noticeable point during the last upward trend of the metal was the maintenance of the contango, there being no apparent scarcity of near tin.

Spelter Market Manipulated.

Values of this metal do not always move consistently with the usual laws of supply and demand. The market is one that is subject to manipulation by interested parties, who paid considerable attention to spelter during the past year. During the first six months the demand was on a very moderate level, although values fluctuated considerably. Home consumption during the second half of the year, however, has been increasing, and although at the close the demand had slackened off somewhat, this was only seasonal. It is anticipated that there will be a considerably greater call for the metal during the first months of the current year. Ostensibly, stocks in this country are small, and this apparent scarcity of spelter is frequently used as a lever to force up prices against the consumer. The American situation fortunately, however, is a factor that has a restraining influence on the course of values in this country. In the United States, the domestic demand is at present small, and production over there could be considerably augmented if necessary. The result is that when, and if, prices reach a sufficiently remunerative level to tempt the American producer, spelter will certainly be shipped across the Atlantic. This has already been done, but not on any substantial scale.

Lead Prices Artificial.

This market also has been subjected to considerable manipulation, particularly during the last quarter of the year. The highest price recorded during the year was £33 for English lead—a price that, taking into consideration the present poor demand for the metal, can only be described as absurd. The high prices have been ascribed by interested parties to the restricted nature of supplies. Published figures have shown stocks to be at a very low level indeed—a level that if a true one would certainly justify still higher prices. There are, however, large quantities of lead held in private warehouses, the presence of which is not broadcast to consumers by those most interested in maintaining values. Just recently, however, there does appear to be some justification for fears of a shortage; with regard to the revolutionary troubles in Mexico, supplies from that country may possibly be cut off.

Contracts Open.

Copenhagen, January 15.—Cast-iron pipes, for the Copenhagen Water Board. Department of Overseas Trade (Room 49).

Dublin, January 18.—Bullhead rails, flat-bottom rails and fishplates of British standard section, also cast-iron chairs and permanent-way fastenings, for the Great Northern Railway (Ireland) Company. Mr. J. B. Stephens, secretary, Amiens Street Station, Dublin.

Johannesburg, January 21.—Meters, etc., for the Municipal Council of Johannesburg. Department of Overseas Trade (Room 52).

Keighley, February 16.—Steel manhole doors, wrought-iron ladders, cast-iron cover plates, strainer guide columns, girders, etc., for the Keighley Corporation. Mr. M. R. Barnett. Town Hall, Keighley.

Stockton-on-Tees, January 12.—Armature coils, axle boxes, pinions, forged-steel axles, iron, brass, steel and malleable castings, iron and steel, etc., for the Joint Tramways Committee of the Stockton-on-Tees and Thornaby Corporations. The Manager, Bridge Road, Stockton-on-Tees.

THE PARTNERSHIP heretofore existing between Messrs. S. Coulter and H. Coulter, iron and steel merchants, George Street, Heckmondwike, trading under the style of John France & Company, has been dissolved. Mr. H. Coulter will carry on the business.

Company News.

Ougree Steel Trading Company, Limited.—Capital £10,000 in £1 shares.

Bars Engineering Company, Limited, Wellington Street, Newton Heath, Manchester.—Capital £1,000 in £1 shares.

Dunloe Engineering Company, Limited, Dunloe Castle, Dunloe, Killarney.—Capital £5,000. Directors: H. S. Harrington and W. B. J. Robertson.

C. O. Mansel & Company, Limited, 17, Bartholomew Row, Birmingham.—Capital £5,000. Metal manufacturers. Managing director: F. C. R. O. Mansel.

London Metal Supply Company, Limited, 213, Forest Road, Walthamstow, London, N.—Capital £300 in £1 shares. Directors: J. P. Chisman and R. Debonnaire.

Robert W. Coan, Limited, 32, Old Jewry, London, E.C.—Capital £30,000. Aluminium founders and engineers, etc. Directors: R. W. and Mrs. Annie Coan.

M. C. Ritchie, Limited, 145, Farringdon Road, London, E.C.—Capital £10,000. Engineers and agents for the sale of machinery, etc. Permanent directors: M. C. Ritchie and E. C. Wykes.

Cotton & Clarke, Limited, 57, Lacy Road, London, S.W.15.—Capital £1,500 in £1 shares. Machinery manufacturers. Directors: A. Walker, R. J. Hughes, C. W. Cotton and A. W. Clarke.

Beeston Radiator and Robin Hood Boiler Company, Limited, Mona Street, Beeston.—Capital £100. Directors: Sir Louis F. Pearson (permanent chairman), Lieut.-Col. N. G. Pearson and G. Smith.

Fermans Die Castings, Limited, Stafford House, King William Street, London, E.C.—Capital £15,000 in £1 shares, to acquire the business carried on at St. Leonards Road, Willesden Junction, and to adopt an agreement with Lightalloys, Limited.

Dominion Steel Corporation, Limited.—Dividend, 1½ per cent. on preference.

William Asquith (1920), Limited.—Interim dividend, 4 per cent. per annum on preference.

Head, Wrightson & Company, Limited.—Interim dividend, 2½ per cent., less tax, on ordinary.

Allen-Liversidge, Limited.—Final dividend, 15 per cent. per annum (less tax), making 12½ per cent. for year.

Edward Wood & Company, Limited.—Dividend, 5 per cent. per annum on preference; no interim dividend on ordinary.

Boulton & Paul, Limited.—Net profit, £4,675; brought forward, £17,930; dividend on preference shares only; carried forward, £20,105.

John & Edwin Wright, Limited.—Balance of revenue account, £12,437; final dividend, 5 per cent. on ordinary, free of tax, making 7½ per cent. for year; carry forward, £6,469.

Components, Limited.—Loss for year, £24,441; amount written off plant, £3,755; amount written off buildings, £1,316; interest on first debentures, £1,637; interest and bank charges, £2,980; balance from last accounts, £1,618; total deficit, £32,511; transfer of reserve fund, £35,000; carry forward, £2,488.

Personal.

MR. C. D. TERRY, son of Mr. A. E. Terry, a director of Herbert Terry & Sons, Limited, spring manufacturers, of Redditch, has joined the staff of the company.

MR. F. C. PYMAN, of West Hartlepool, managing director of William Gray & Company, Limited, shipbuilders, has been elected a director of the Iron Trades Employers' Insurance Association in place of the late Mr. George Jones.

Wills.

HOWARD, W. H., of Padgate Lane, Padgate, Lancs., metal merchant	£8,198
DIXON, C. F., managing director of the Cleveland Bridge & Engineering Company, Limited	£19,917
HARKER, DR. J. A., of Clarghyll Hall, Alston, Cumberland, formerly Director of Research at the Ministry of Munitions, and Chief Assistant at the National Physical Laboratory	£6,739

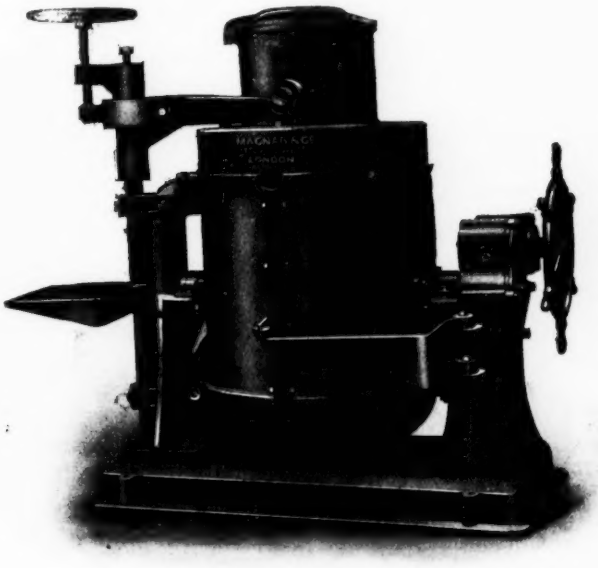
THE JOINT AUDIT in connection with the South Wales and Monmouthshire iron and steel industry for the three months ending November 30 last shows a reduction in the average selling price of steel rails and tinplate bars of 7s. 10.07d. per ton, which means a decrease of 4 per cent. in the sliding-scale governing workmen's wages. The sliding-scale, therefore, for the quarter commencing January 1, will fall from 63¾ to 59¾ per cent. above standard rates.

MACNAB & CO.

METAL MELTING CRUCIBLE FURNACE

For Brass, Gunmetal, Aluminium, Iron, etc.

Reduce your fuel cost! **Melt in a hurry!**



Tylor Patent Pit-Type Furnace.

OUTPUT.
200 lbs. Admiralty Gunmetal melted in 35 minutes. Temperature 2000° F.=1093° C.

ECONOMY.
25 lbs. of Coke used per 200 lbs. of Metal melted.

STANDARD CRUCIBLES.
Lasting 35 to 40 heats.

Tylor Patent Tilting-Type Furnace.

OUTPUT.
450 lbs. Admiralty Gunmetal melted in 50 minutes. Temperature 2000° F.=1093° C.

ECONOMY.
80 lbs. of Coke used per 450 lbs. of Metal melted.

STANDARD CRUCIBLES.
Lasting 30 to 40 heats.

56/8, EAGLE STREET, SOUTHAMPTON ROW, LONDON, W.C.1.

Works: TOTTENHAM, LONDON, N.17.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—With the conclusion of the Christmas and New Year's holidays, both of which are celebrated in the Tees-side districts, the Cleveland iron market has only resumed active business this week, with, however, certainly improved prospects as far as home consumers' requirements are concerned. In the intervening period there will necessarily have been a certain volume of orders accumulated, which should accelerate the usual active buying at the opening of the first quarter, and it may be hoped will have a favourable effect also upon the export trade, of late in a far from satisfactory condition. Another stimulating factor in the position is an improved inquiry for foundry products following some heavy contracts recently placed by engineering firms and railway companies in connection with extensive public works developments, which must necessarily be to the advantage of the smelting industry.

Business in hematite has been obviously interrupted, but the position is inherently strong, and values are unaltered. For East Coast mixed numbers 102s. 6d. is a bed-rock figure, and the No. 1 quality is fully 1s. per ton more. In the North-West area Bessemer mixed numbers are still quoted at £5 15s. per ton, delivered at Glasgow and Sheffield, and £6 at Birmingham. Low-phosphorus iron is in steady request by users in the Sheffield district.

MANCHESTER.—Although the outlook in the Lancashire iron trade is distinctly more favourable than for some time past, very few buying orders have yet been placed in this market, and prices of Derbyshire foundry quality pig are still unaltered on the basis of 95s. per ton for prompt transactions. This being one of the lowest of the Derbyshire rates means a delivered price in Manchester of 102s. 6d. per ton, but most of the other sellers of Derbyshire iron are quoting from 103s. 3d. to 103s. 6d. per ton delivered for prompt iron. There is now some Lincolnshire foundry iron being offered here for January and February delivery at the same price—on trucks—as the cheapest Derbyshire iron, but as the rail rate is higher the cost of this iron in Manchester is 104s. per ton.

THE MIDLANDS.—Market movements in this area are on a restricted scale pending developments at the quarterly meeting to be held during the current week, but manufacturers report that they are fairly well sold, although the demand is not so strong as it was a month or so ago. Many foundries have bought as far ahead as March, and reports suggest an improvement in the demand for castings.

SCOTLAND.—As works in the industrial districts only resumed operations at the beginning of the week, there is practically little actual business passing in the pig-iron market, leaving prices for the moment unchanged, makers' quotations for No. 3 remaining at 107s. 6d. f.o.t. furnaces. It is generally expected that there will be a lull in buying for a spell, most consumers having made fairly good purchases which they have to take over the next few months. There is still no improvement in the export demand, and even inquiries are few.

Finished Iron.

The markets for finished material maintain the steadiness recently reported, but the improvement is very gradual, though certain; there has been no change in price. It is understood that some good railway orders are about to be given out, and the tone generally is more hopeful. Taking everything into consideration, 1924 opens out better prospects than the preceding two years. A more hopeful feeling is manifest in every section of the trade.

Steel.

Holiday influences having subsided, business in the steel market may now be expected to take a more active turn, and favoured by the numerous large specifications in connection with home and foreign railway developments, etc., hopes are confidently entertained of a successful expansion of the industry as the year advances.

Scrap.

More activity has been in evidence in the various scrap markets this week, and with consumers' demands on an increasing scale it is confidently expected that the improvement recently noted in the trade will be continued. That there are more orders—and a good many more—at the Lancashire iron foundries is generally admitted, and as these consumers have bought largely of pig-iron recently, but only very sparingly of scrap, it is a fair inference that when they get more fully to work they will be in want of scrap. At the moment the discrepancy in prices between cast scrap and pig-iron, although not so glaring as it was, is sufficiently great. Occasionally fine lots of textile machinery scrap are reported as being sold at 95s., but this seems to be an unusual price. More generally cast scrap varies from 85s. to 90s. per ton. The quantities in the market are fairly large, but with any degree of activity in the foundry trade this position would very soon be changed. In Yorkshire many works have now good stocks, sufficient to meet their needs for the time being, and buyers are looking for a weakening of prices.

Metals.

Tin.—The slightly weaker tendency recently noted in the standard tin market has since vanished, consequent, probably, to renewed buying after the holiday period and the firming effect of the statistical position. There has been a slight recovery in the Straits production, according to the official returns for more recent months, but tin is being continuously shipped at a rate materially in excess of current output, and the surplus of controlled tin is being drawn upon from month to month on a sufficiently important scale as to create the impression that there is a possibility of the market being confronted later on with scarcity.

Ricard & Freiwald's statistics of tin for December are appended :—

STOCKS, LANDING AND AFLOAT, EUROPE AND AMERICA.—United Kingdom: Stocks in London, 1,702 tons; stocks in other ports, 2,200 tons; total, 3,902 tons; landing and in transit, 452 tons; afloat from Straits, 905 tons; afloat from Australia, 100 tons; total, United Kingdom, 5,359 tons. Holland: Banca spot, 1,899 tons; Banca and/or Billiton afloat to Europe and America, 216 tons. Continent: Straits afloat, 830 tons. United States: Spot and landing, 1,652 tons; afloat, 8,675 tons; total visible supply, 18,631 tons.

Current quotations: — *Cash*: Thursday, £238 12s. 6d.; Friday, £236; Monday, £238; Tuesday, £242 5s.; Wednesday, £244 5s. *Three Months*: Thursday, £239 17s. 6d.; Friday, £237 5s.; Monday, £239 10s.; Tuesday, £243 10s.; Wednesday, £245 10s.

Copper.—The outlook in this section of the metal markets continues fairly satisfactory, a steady consumptive demand assuring a certain degree of support on the part of buyers for actual industrial requirements. This hopeful feeling is also expressed amongst large dealers, while the commitments open on the short side, entered into recently on a considerable scale, may lead to some pressure of repurchases in the event of a fresh buying movement on the part of American consumers in the immediate future. Producers' terms lately have been very well maintained, and seem unlikely to be shaded to any notable extent, chiefly in view of the comparative scarcity of second-hand offers. French and Italian electrification schemes are going ahead, and the state of the electrical trades in this country is considered very satisfactory, although business conditions with sheet-makers remain disappointing. Current quotations:—*Cash*: Thursday, £61 10s.; Friday, £61 5s.; Monday, £60 17s. 6d.; Tuesday, £61 7s. 6d.; Wednesday, £60 17s. 6d. *Three Months*: Thursday, £62 2s. 6d.; Friday, £61 17s. 6d.; Monday, £61 12s. 6d.; Tuesday, £62; Wednesday, £61 10s.

Spelter.—Movements in spelter have, of late, taken a rather more active tendency, and increasing interest has been evidenced in forward business, due to prospects of a better consumptive demand during the earlier months of the year. The imports for last month amounted to 10,862 tons, as against only 5,843 tons for November last year, the aggregate for the eleven months representing 119,320 tons, which is an excess of about 50,000 tons as compared with the corresponding period of 1922. Home consumption in the second half of this year has been increasing, and so far as can be seen incomings have been by no means excessive. Current quotations:—*Ordinary*: Thursday, £33 6s. 3d.; Friday, £33 10s.; Monday, £34 2s. 6d.; Tuesday, £34 7s. 6d.; Wednesday, £34 8s. 9d.

Lead.—The market for soft foreign pig continues practically unchanged. So far, little further is disclosed with regard to the situation in Mexico, but sufficient is known to support the firmness already apparent in values.—Current quotations:—*Soft foreign (prompt)*: Thursday, £30 15s.; Friday, £30 15s.; Monday, £30 15s.; Tuesday, £30 17s. 6d.; Wednesday, £30 16s. 3d.

XUM